Note

P.G. DIPLOMA IN ENVIRONMENTAL STUDIES ENVIRONMENTAL GEOSCIENCES

Block	1	:	Foundamentals
Block	2	:	Geological Hazards
Block	3	:	Resources
Block	4	:	Development & its Impact
Block	5	:	Pollution & Management

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Dr. B.R. AMBEDKAR OPEN UNIVERSITY
HYDERABAD
2003

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PREFACE

This book deals with Environmental Geosciences included in the syllabus of P.G. Diploma in Environmental studies offered by Dr. B.R. Ambedkar Open University. The topics included in this course cover the specialisation on 'geo environmental issues' of the programme. This syllabus for the sake of convenience is divided into blocks, each of which comprises a number of units. Each block generally covers a specific area of the subject. The units are written by the specialists in accordance with a format specially designed as to enable the student to read and understand the contents without much difficulty. Each unit begins with a statement of its contents followed by objectives. Each unit has at its end summary and model answers for the questions given under check your progress. Three assignments are given at the end of the book and the student is expected to submit atleast one assignment to the Coordinator/Asst. Director/Deputy Director of the concerned study centre.

This book deals with the various aspects relating to environmental issues of geology. The topics covered are atmosphere, thermal environments, green house effect, geological hazards such as volcanoes, Earthquakes, landslides, cyclones, floods and drought, resources exploitation, mining and water resources. The environmental problems with Dams, Reservoirs, Buildings, Bridges, Roads, Tunnels are also covered. The various types of pollution, quality of ground water, solid waste disposal are also discussed. Finally the environmental policy and law are analysed.

The university hopes that this material will help the student to get acquainted with main issues of geological environment. Critical suggestions for improving the text are most welcome and they will be incorporated in the future edition.

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BLOCK - 1
FUNDAMENTALS

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UNIT-1 : SCOPE AND DEVELOPMENT OF ENVIRONMENTAL GEOSCIENCES

Contents

1.1. Objectives
1.2. Introduction
1.3. Environmental Geosciences - Objectives
1.4. Scope
1.5. Basic Concepts
1.6. Summary
1.7. Check Your Progress : Model Answers
1.8. Model Examination Questions

1.1. OBJECTIVES

After studying this unit, you should be able to :

* define environmental geosciences.
* explain the objectives and scope of environmental geosciences.
* describe the basic concepts of environmental geosciences.

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1.2. INTRODUCTION

Environmental geosciences is a branch of geology. This course creates an awareness for preserving the natural environment, conserving the earth's resources, coping with geological hazards and participating in technological and industrial development without disturbing the ecological balance.

Ever since the human race took to agriculture, the symptoms of deterioration of the environment started. The reclamation of grass lands for cultivation initiated an unpending cycle of erosion of the soil. The farm lands were expanded at the cost of forests leading to loss of vegetal cover. K.S. Valdiya quoted India is losing forest cover at the rate of 441 hectares/day causing the expansion of dry land.

About 60,000 sq.km. of land all over the world is annually falling victim to the process of desertification, ultimately leading to recurring droughts. The over population and livestock in villages and towns has added the generation of wastes and proliferation of pollution, with the attendant spread of diseases. The population growth automatically demanding more food and natural resources like fuel, energy and water. As a result of unchecked growth of population there is an uninterrupted, unending flight of people from rural to urban centres, so that towns and cities have become conglomerations of slums. In the absence of environmental planning and resource management the slums in most developing countries including India have become expanding focal centres of scarcity, inflation, economic destitution, unemployment and stagnation of socio cultural development.

Environmental geoscience is that area of specialization that takes mankind as the central figure of investigation. It is an applied and also practical science. The primary

concern is to determine which type of construction and resources extraction methods minimise distortions of the land water ecosystem. The same may be called by some authors as **Environmental Geology.**

1.3. ENVIRONMENTAL GEOSCIENCES - OBJECTIVES

For the growing needs of the human population, man has to exploit resources, but this will not be effect to the other organisms and also the forth coming generations. The over exploitation without proper care and management, generally leads to degradation of environment and pose a threat to his own well-being and even survival in some areas. In addition man has to face the natural hazards like volcanoes, earthquakes arising from the dynamic activity of the earth. The developmental projects without proper legislation are proving as dangerous segments to our world. Hence there is decreasing happiness for many with increasing comfort for a few.

This environmental geosciences deals with the interrelationship of various earth processes, their consequences and the activities of man who forms the central figure in the environmental scheme of things. This course embraces coordinated and integrated studies and the application of geosciences for the improvement and preservation of the environment through a more judicious use of natural resources, and by ensuring the safe guards against degradation of land and contamination of air and water. The better quality of life can be achieved through use of the land in accordance with its capabilities, better management of water resources and judicious utilization of mineral and energy resources without endangering their bases. The primary objectives is to aid in those studies and decisions in order to minimise the human impact on the human environment.

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1.4. SCOPE

The scope of Environmental geosciences is very broad. It consists of not only the subdisciplines of geology but also the other physical, biological and social sciences. This course also comprises of the environmental aspects of engineering, landscape architecture and soil science. On the whole this discipline embraces the total gamut of human use of the earth-the prediction, assessment and combating of natural hazards and the application of technology and engineering for the development of society without destruction of environment. So the environmental geoscientists has to evaluate the appropriate sites for construction of buildings, dams and bridges and has to develop proper exploitation methods for natural resources without causing damage to surroundings.

The major areas where environmental geosciences plays vital role are discussed here.

(i) **Earth resources** : Minerals, oils and gas, soil etc. are depleting at faster rate, as these are the non-renewable resources, proper conservation and management procedures can only solve the problems. The exploitation, beneficiation, usage all are related to environment. If proper methods are not used environment may be damaged. Conservation and management of earth resources is important in the course of environmental geosciences.

(ii) **Water :** Water is the most vital source for the sustainable development of living things. This resource of required quality are available in limited extent, so its judicious use without deterioration of its purity, freshness and source are essential elements for environmental management of water. The qualitative and quantitative appraisal of surface and ground water is thus an important issue in environmental geosciences.

(iii) **Natural hazards/Geological hazards :** A geological hazard is a phenomenon associated with geologic process that can produce a disaster when a critical point is exceeeded and can result in significant loss in life and property. The natural hazards of this type are **volcanoes, earthquakes, cyclones**, etc. which will cause damage within a short duration. By mapping of hazard-prone areas and avoiding occupation in such areas may benefit from the disasters. However, the incidence of human induced changes such as **landslides, subsidence, floods, desertification** can certainly be minimised by taking necessary precautions. Here environmental geosciences plays major role to identify the conditions that cause hazardous events, can offer plans to cope with and combat such hazards.

(iv) **Developments and Technology :** Man effects nature by the metamorphosis of landscape, it means men for their comfort, developing dams, reservoirs, buildings, bridges, roads, canals, tunnels etc. The side effects and backlash of such developmental activities in many cases proved counterproductive. Environmental geosciences comprises various studies of terrain evaluations, stability of slopes, testing of the ground to withstand anticipated load and recommendations to counter the damages.

(v) **Pollution and Waste Disposal :** The manufacturing, mining and ultimate disposal of the by-products of civilization impose a tremendous alteration of natural systems. The dumping of large volumes of waste threatens not only to deface the landscape but also to pollute the air and water. The environmental geosciences is related to this waste disposal and pollution in a way to locate suitable sites for disposal of waste, to know the exact causes of pollution of air, soil, surface water and ground water and remedial measures for avoiding the pollution of the above.

Apart from the above five fields environmental geosciences also useful in maintaining pollution free ecosystem and for the development of energy without causing damage to environment.

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Check Your Progress 1 & 2

1. What is the primary objective of environmental geosciences ?
2. Write any three major areas where environmental geosciences plays vital role?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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1.5. BASIC CONCEPTS

In the first part, we have been introduced to the objectives and scope of environmental geosciences. Now we are discussing about some guide posts to serve as focal points for the various topics. These are the basic concepts developed by Donald, R. Coates. They are 10 concepts, which are intended to indicate the unifying threads that are interwoven into the fabric of this course. Environmental geosciences course is a mission oriented and problem solving discipline. This differs from other research because in other fields the scientist has greater freedom to select the problem. In environmental geosciences, however the problem already exists or its occurrence can be predicted. The first five basic concept concern physical systems and geological fundamentals. Concepts 6,7 and 8 deal with the causes, and status of problem, whereas concepts 9 and 10 refer to the resolution of problems and environmental ethics.

Concept 1 Complexity is the norm in physical system.

It means any action may be influenced by many different factors. For example landslides can be caused by several factors either individually or together, landslides may be occurred due to excessive rain-fall, earthquakes or human intervention, but these are only the immediate cause. For landsliding, there must also be some underlying and innate weakness in earth materials and structures. Thus one physical system has been superimposed on another physical system. The combined effect only leads to final damage on the earth surface.

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Concept 2 Human-induced changes to the land water invariably, produce environmental feed back systems.

Ground water mining is the best example for feed back mechanisms. Excessive withdrawal results that recharge of anquifer cannot keep pace with discharges and the watertable lowers. Unconsolidated sediments can collapse resulting in subsidence of land surface. Further more deep water commonly have more dissolved solids because of longer stagnation. Here the problem of subsidence of land surface, more dissolved solids, are the environmental feed back systems of human induced excessive withdrawal of ground water.

Concept 3 Geologic thresholds are an ever-present danger in coping with the environment.

Any process which exceeds critical point or threshold can initiate rapid and extreme change. When ever geologic hazards viz earthquakes, volcanoes, floods, landslides, etc. occurs the thresholds shows extraordinary positions. For example a fault occurs when the yield strength [a threshold] of the rock exceeds, causing a rapid displacement of earth materials.

Concept 4 The geologic environment contain both open and closed systems.

A system is open if there is a free flow of mass and energy into and out of the system. A system is closed when no external components enter the system and nothing leaves it. Hydrological cycle and rock cycle are the open system. When such systems are unduly influenced, thus may become closed systems operating only on internal adjustments. It should be obvious that the recognition of systems and their behaviour is vital ingredients in our environmental management. These systems can be altered to certain extent only, if we crosses such limits it will effect the natural system.

Concept 5 Resources can be categorised as to whether they are renewable or non renewable.

Resources are those products that enable human life to be sustained. Solar energy, soil, terrain, rivers, lakes, oceans, wet lands, forests, grasses, weather etc. all are resources. Some are renewable and some are non renewable. It is important that environmental managers have a full understanding of the finite character of non renewable resources as compared to the regeneration of living resources. The over exploitation of resources poses problems for management of resources and the economy of any country.

Concept 6 Environmental problems are universal.

Environmental damage is universal. All places and all people are not affected with same problems but immunity is the exception and not the rule. Because we live on earth's surface, it is inevitable that our activities cause changes in land-water ecosystems. These changes range form the creation of microclimates in urban areas to the desertification of huge regions. We are rarely safe either from ourselves or from natural process. Geologic hazards are an everpresent threat and disasters occur at alarming frequencies. Environmental geosciences is an important solution because the common base of the problems rests with earth resources and the technology to make them avoidable.

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Concept 7 There is an exponential rate of increase in environmental deterioration.

The population growth demands more resources and leads to cumulative degradation in expanding rate of environmental change. The population explosion required accelerated production of materials and energy. The development in science and technology increases the ability of man to change land water-ecosystems. This alternately leads to more and more environmental deterioration.

Concept 8 Environmental decisions invariably involve and produce internal conflicts.

Environmental conflicts arise largely through the problem of how to decide which system of priorities to adopt. Typical conflicts arise among young and old, the rich and the poor, the urban people and rural people and so forth. When all people are allowed equal access to a common ground, the usage becomes so heavy that the site in question is destroyed and becomes useless to any one. Thus environmental management is one of the primary aspects where the conflicts have been fought.

Concept 9 The majority of environmental decisions should be based on benefit-cost analysis.

It should be obvious that a given action will not be undertaken if the predicted costs exceeds the predicted benefits. The principle underlying this concept is that objective

and measured properties will be evaluated as an economic calculus to derive numbers that will stand up under so vital scrutiny. The true costs involved with nuclear plants should include all phases of the miners, the plant cost and effluent impacts, and the disposal of wastes and other health and risk factors. The importance of benefit-cost analysis is that it provides a base for decision making, standardise a method, and makes possible a wider, more understandable concept for people in the political process.

Concept 10 Environmental stewardship is prerequisite to long-range compatibility of man and nature.

Environmental stewardship implies a constructive liaison between man and nature, it means we have a longer responsibility than to ourselves alone, which includes empathy for natural things and processes and consideration for society and future generations. Environmental geoscientist must wear more than one hat. Not only do they need to determine and to interpret facts and data on which decisions may be based, but they should also articulate their findings and be willing to share their judgements in public forum. Environmental stewardship can only be successful if geoscientists are willing to aid in educating the general public on the issues, to place their data and ideas before the planners and managers and to become an integral part of the decision making administration.

Check Your Progress 3 & 4

3. Who has developed these basic concepts of Environmental geosciences ?
4. What is the concept number 6 ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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1.6. SUMMARY

Environmental geosciences creates awareness for preserving the natural environment, conserving the earth's resources, coping with geological hazards and participating in technological development without disturbing the ecological balance. Environmental geoscience is that area of specialization that take mankind as the central figure of investigation. The primary concern is to determine which type of construction or resources extraction methods minimise the distortions of land-water ecosystem. The objective of this course is coordinated and integrated studies and application of

geoscience for the improvement and preservation of environment and also to minimise the human impact on the human environment. The course consists of not only the sub discipline of geology but also the other physical, biological and social sciences. This course also comprises environmental aspects of engineering, landscape architecture and soil science.

Earth resources, water, natural hazards/geological hazards, development and technology, pollution and waste disposal are the important areas where this course plays vital role. Basic concepts were identified by D.R. Coats. These are 10 concepts which are intended to indicate the unifying threads that are interwoven into the fabric of this course. This course is a mission oriented and differ from other research because in other fields the scientists has greater freedom to select the problem but in this science the problem already exists or its occurrence can be predicted. The first 5 concepts deals with physical systems and geological fundamentals, the 6,7 & 8 deals with the causes and status of problem where as the 9 and 10 concepts refer to the resolution of problem and environmental ethics.

1.7. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The primary object of Environmental geosciences is to minimise the human impact on natural environment.
2. Environmental geosciences plays vital role in (i) Earth resources (ii) Water (iii) Natural / Geologic hazards (iv) Development and technology (v) Pollution and waste disposal etc.
3. The basic concepts of Environmental geosciences was developed by Donald, R. Coates.
4. Environmental problems are universal is the Donald, R. Coates sixth basic concept.

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1.8. MODEL EXAMINATION QUESTIONS

I. Answer the following in about 30 lines each.

1. Write about the objectives and scope of Environmental geosciences.
2. Write down the basic concepts of Environmental geosciences developed by Donald, R. Coates.

II. Answer the following in about 10 lines each

1. Write down the relationship between water and Environmental geosciences
2. How natural hazards are part of Environmental geosciences.

Dr. P. Madhusudhana Reddy

UNIT-2: HISTORICAL PROSPECTIVES AND PHYSICAL SYSTEMS

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  2.2.2. Ancient World
  2.2.3. Geological Conservation
2.3. Physical Systems
  2.3.1. Minerals and Rocks
  2.3.2. Weathering
  2.3.3. Soil
  2.3.4. Gravity Movements
  2.3.5. Running Water
  2.3.6. Coastal Systems
  2.3.7. Ground Water
  2.3.8. Wind
2.4. Summary
2.5. Check Your Progress : Model Answers
2.6. Model Examination Questions

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2.1. OBJECTIVES

After completion of this unit you should be able to :

* explain the relation between man and nature.
* describe the geologic conservation.
* define physical systems.
* explain how the minerals and rocks, weathering, soil, gravity movements influence environment.
* describes the impact of running water, coastal system, ground water and wind.

2.2. INTRODUCTION - HISTORICAL PROSPECTIVES

History of the human beings is closely linked with environmental setting. We construct homes and buildings out of the nearby avoilable natural materials. We select our home site at places of convenience, necessity, or safety depending upon our perception of the environment. Some times this type of selection may superceeds the possible dangers involved in it, thus we build in the shadow of volcanoes, because the soil is rich, or on flood plains because building costs are low due to plain land, and waste disposal is easy. The hazards are therefore neglected. Man developed greater sophistication in the understanding and evaluation of natural resources or earth materials. The usual succession runs from the stone age, copper age, bronge age and iron age. Several advancements have been made with the coal age, petroleum age and

nuclear age. Such historical modifications would be represented by **Agricultural revolution, Industrial revolution, Electrical revolution, Automotive revolution, Urban revolution and Communication revolution.**

2.2.1. Relationship Between Man and Nature

Early man was the internal part of nature and environment. During that period man was intelligent animal and existed by gathering food with hunting. The first major impact on environment by man was started with the discovering of man's ability to create and control fire. This gave him a new weapon to round up, trap or drive game by deliberately setting fires. This was not only the start of man made pollution but also set the state for the first large scale increase in erosion rates. After starting agricultural procedures man changed his life style from nomadic to sedentary with concentration of people. The longer residence at a single place allowed for repeated alterations of soil and water bodies. Mixed cultivation led to the larger concentrations of cattle, sheep and goats which were forced to stay with humans in the same area. The cutting of forests for use as timber in buildings and for fuel also led to increased erosion of soil.

In the agricultural procedures, due to high evaporation of irrigated water left behind salt residues that destroyed soil fertility. During the metal age due to scarce abundance of metals like iron, copper, tin etc. in some locations led to new discoveries and colonization. The industrial revolution created massive dislocation of people and resources caused the rapid growth of cities around major industrial plants. First air pollution started on large scale with this industrial development. The industrial revolution also was instrumental in causing the redistribution of wealth, goods and services, with this trade and commerce was increased. Into such industrial areas people were migrated and settled as urban people. So through a series of technological advances, social and commercial innovations the seeds were sown for the urban revolution. Urban revolution creates environmental problems to nature with waste water, sewage, drainage systems. Supply of drinking water also a problem, so people started exploring ground water causing lowering of water table. The historical civilization made man adverse towards nature. The service with expanding population, we had to change nature to suit our growing needs. Throughout history there has been a dichotomy between man and nature.

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2.2.2. Ancient World

During the pre-history time man was a food hunter-food collector exploiting wild species of plants and animals. Animal husbandry and agriculture became necessary when man was expending more energy in hunting, fishing and food gathering. Thus animals when domesticated became labour-saving devices, source of food and dung could be useful as fertilizer and fuel. Same way growing of crops in the broad valleys led to sedentary life. Later in the early history period man has developed more arts, crafts and writing. The successful search and use of minerals led to a series of ages viz. coper age, bronge age, iron age etc. Civilization started in this period with development of towns and cities. Later in some cases environmental factors influenced the decline of several civilizations. Salinization, soil erosion, siltation of lakes and water sources forced to decline civilizations. The three important factors significant to environment are [1] climatic deterioration [2] mineral resource depletion

and [3] soil degradation. These factors greatly influenced the civilizations in the ancient time. Now a days several man-made innovations drastically changed our living patterns. The population explosion and urbanization vastly changed the land scape, and also the nuclear race and energy crisis caused many problems.

2.2.3. Geological Conservation

Geologic conservation mainly emphasises on the totality of human effort to deal with the effective management of the earth's surface and sub-surface resources, such as soil, water, minerals and fuel with reclamation and rehabilitation of damaged environments.

Conservation is essential for the sustainable development of mankind. It is not good to enjoy the resources at present, one has to think of future generations. Soil conservation consists of maintainance balance in the soil profile and prevent excessive erosion or deterioration. Natural resources conservation involves planning, extraction, marketing and use for the long-range utilization by man. Reclamation and rehabilitation are two different aspects of conservation that deal with man's deliberate attempts to change or restore environment. Alongwith conservation man has to develop new strategies and device new materials for survival that are equal or better than those which have been destroyed. If not environmental degradation continues further.

Check Your Progress 1 & 2

1. How does soil looses fertility ?
2. What are the agents in urban pollution ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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2.3. PHYSICAL SYSTEMS

Geology has the central purpose of cataloging, classifying, understanding and predicting those phenomena, processes and features that produce materials and changes on and with in the earth. The distinguishing characteristic of geology is the time scale and importance of events and materials that range from the microscopic to those measured in thousands of kilometers and events that occur in micro seconds as well as millions of years. Dating of geological events is very important for making decisions towards environmental problems. For example the siting of nuclear plants is based on the dating of possible seismic events and management of flood plains is determined by the statistics of frequency of flooding based on time considerations. The important physical systems in environmental geosciences are the minerals and rocks, weathering, soils, gravity movements, running water, coastal systems, ground water, wind etc.

2.3.1. Minerals and Rocks

Minerals are naturally occurring inorganic elements or compounds with definite physical or chemical properties in crystalline form. So far more than 2000 rock forming minerals were identified and grouped into six families. They are quartz group, feldspar group, mica group, amphibole group, pyroxene group and olivine group. 98% of the earth crust are composed of only 8 elements namely oxygen, silica, aluminium, iron, calcium, sodium, potassium and magnesium. Minerals containing these 8 elements are abundant in earth. The main interest in the mineralogical study is [1] how they combine to form rocks [2] economic importance [3] stability towards weathering and soil formation [4] their strength for using in construction.

Rocks are the aggregate of minerals. Except soil, water and organic materials all of the earth that what we can see above and below ground consists of rocks. Geologist classified rocks based on their origin into three groups. The first namely **igneous rocks**, which were originated due to crystallization of molten matter. Intrusive [plutonic] rocks originate many kilometers below the surface and are seen when the upper cover removed by erosion. Granite is a intrusive rock. Extrusive [volcanic] rocks originates when the molten rock oozes to the surface. Basalt is a extrusive rock. The second group is called **Sedimentary rocks** form from redeposited broken debris and matter from other rocks that accumulate on earths surface. Sedimentary rocks may be either mechanically formed as shale and sandstone or may be chemical precipitates like limestone. The third group **Metamorphic rocks** originates from the application of heat, pressure and chemically active fluids on preexisting rocks. Under these changed environment older rocks are transformed into different rocks with new properties. Gneiss, Schist, Marble, Quartzite are some examples.

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2.3.2. Weathering

Weathering is a process by which the soils are forming. Weathering may be defined as the physical disintegration and chemical decomposition of the rocks exposed to surface. The physical desintigration is effected with frost action, temperature, gravity and organic life. The chemical decomposition is due to the processes like hydration, oxidation, solution, carbonation etc. Weathering some times confused with the process of erosion, but differences exist in the type of force and particle motion. Weathering should be restricted to passive forces that produce breakdown of rocks in place. Whereas erosion is a dynamic force that involves the removal of material from the site and its transportation to a new place.

2.3.3. Soil

Soil is the upper part of the earth with unconsolidated or weakly cemented sediments with the total thickness of the weathered material resting on bed rock. Most of the land surface of earth is covered with soil exception with glaciers, desert waste lands and on the bed rock exposure in hilly and mountain regions. In general the top soil is with a thickness of one meter, where as the subsoil and weathered zone may be more than 100 mts. in semi tropical-tropical environments. Based on the soil thickness, maturity, composition, texture and colour several varieties were identified. A well developed soil may contain humus and organic debris in the upper portion and in the middle it contains only the most weathering-resistant minerals, whereas in the lower portion contains least changed constituents of bed rock. Soil characteristics and types are of special concern to man because they determine the degree if fertility, the type of crops

that can be grown, and the land use practices that should be adopted. The factors that govern soil type, its formation and its rate of development include [1] original rock type [2] climate [3] topographic aspect [4] organic process and [5] time.

Check Your Progress 3 & 4

3. Define mineral and rock ?

4. What is meant by weathering ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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2.3.4. Gravity Movements

The downslope movement of earth materials caused by the gravitional force is termed as **gravity movements** which are universal. Although gravitational attraction is directed towards the earth's centre, all sloping surfaces have downhill components of this stress. The small moments are called as mass movements or mass wasting. If it happens in large area it is called sliding. The force of gravity also provides the energy to cause water to flow in streams, ice to move in glaciers, ground water to develop hydrostatic pressure and eventually move to lower elevations. Every earth material has its own angle of stability towards gravity. When ever this equilibrium fails movements will occur. There are three important gravity movements namely **creep, landslides** and **subsidence.**

Creep is the slow gravity movement of surface material. It generally involves different types of unconsolidated rock fragments. If the weathered soil profile moves, it is called soil creep, rocks are in motion it is rock creep, and rock fragments along foot of mountains involved it is termed as talus creep. A general term used to describe gravity-displaced regolith is colluvium in distinction from alluvium, which is stream-deposited sediment. **Landslide** is one where the rocks shows resistance against gravity for long period and then suddenly fails resulting in rapid dislodgment of surface materials. Landslides may be natural or man induced. **Subsidence** is one where the displaced material moves vertically. If the movement is sudden it is called collapse and the movement is slow due to man made structures it is termed as settlement. Subsidence can be natural or man induced. Subsidence is becoming an increasing important factor in land use planning.

2.3.5. Running Water

Water is very important in the environmental sciences. It is such a special commodity that is existing only on our planet earth, water covers about 71% of the earth's surface. The term running water is used to the channelized flow in river system. Running water is the primary sculpturer of landscapes. The **stream** is the general word used for all sizes of flows such as washes, creeks, rivers etc. A stream has a definite drainage basin, whereas smaller scale downslope water paths are referred to as hills and gullies. **Influent streams** are those where their water recharges the groundwater, where as **effluent streams** will get water from the ground water. Streams are important in landscape development. Movement of water and debris into the stream comes from the volley walls by sheet wash and gravity movement. The release of industrial waste into streams causes environmental pollution. For management purpose the study of running water and the receptical surrounding it are essential to policies that deal with fluvial systems.

2.3.6. Coastal Systems

Coastal systems are more complex because the process involved along the shore line are highly variable and of different types. This land-water interface is subjected to forces that operate on the land as well as those generated in coastal waters. Streams and gravity movements can influence coastal systems as well as lake or marine waters themselves. The shore line is a conglomeration of land forms that at the present time show a rising sea level; water and sediment from fluvial systems; gravity slope movements; tidal fluctuations and currents; waves; tsunamis; longshore currents; and oceanic currents. Process that act in the coastal area produce landforms that change more constantly and regularly than in other environments. This is especially true for beaches, since these features can change twice daily due to differences in tidal heights. In most instances, the winter beach is characterised by erosional process whereas in the summer the beach generally undergoes a period of buildup and deposition. Again due to man-induced activities coastal systems are changing and causing environmental problems. Based on [1] the geologic-geomorphic history [2] the erosion-deposition flux [3] subaqueous profile and [4] characteristics of the seas at and in the vicinity of shore coastal areas are classified into different types.

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Check Your Progress 6 & 7

5. Explain the difference between creep and subsidence.
6. Identify the difference between influent stream and effluent streams.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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2.3.7. Groundwater

Water existing in the liquid, solid or gaseous state in the rocks of the earth is called sub-surface water. **Groundwater** is part of sub-surface water, occurs in the zone of saturation in which all interconnected voids in the rocks are filled with water. The upper surface of this zone of saturation is called **water table**. The depth of water table is highly variable and depends mostly on climate. The lower limit of zone of saturation extends to depths at which the interconnected openings filled with water are so few that they have no practical significance. The width of the zone of saturation may be exceedingly small in areas underlaid by consolidated rocks with joints tampering at shallow depth, are may be several thousands of metres in areas underlaid by a thick sequence of sedimentary rocks as in the Ganga basin.

Groundwater is a fundamental component in the hydrological cycle. The origin of groundwater may through infiltration of rain water and from nearby river or lake. Groundwater is a both cementing medium that can bind sediments together into a rock and a destroyer of rock especially the carbonates and sulphates. Ground water system can be divided into two main groups. The most common is an unconfined system in which ground water movement bears a similarity to electric flow through a homogeneous medium. The flow paths are response to gravity pressure head. In the second type under special conditions groundwater moves under confined system and ground water moves freely from place to place depending with gravity.

Groundwater is important because it [1] performs work in the erosion, transportation and deposition of material [2] is an essential part of hydrological cycle [3] supplies plants and animals their water requirement [4] influence the growth of vegetation which controls erosion by gravity movements, streams and winds.

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2.3.8. Wind

The movement of air in the atmosphere is known as **wind**. Wind is very important in the formation of ocean waves and waves create more coastal changes than all other processes that act on shoreline. Wind distributes precipitation and is the determining factor that influences storm severity and also distributes atmospheric heat; thus becomes the cause of deterioration of rocks by weathering. The effects of wind are universal and not restrictive. Further more wind has no constant direction. The effect of wind is clearly visible in desert and arid terrain. In deserts sand dunes are more common.

The direct work of wind is performed in three ways [1] abrasion [2] deflation, the flowing away of material [3] transportation. Some times it changes landforms. Pediments can be formed due to wind. It is the only process capable of transportation material around the world. Wind plays vital role in the environmental scheme of things.

2.4. SUMMARY

Environmental setting is closely linked with the history of man. We build our houses in the shadow of volcanoes because the soil is rich, or in flood plains because building cost are low due to plain land. The hazards are therefore neglected. The scientific development brought some good things with environmental problems. Early man was the internal part of nature and existed by gathering food with hunting. Man's ability to create fire caused the first impact on environment. Agricultural procedures made man to longer residence at a single place caused degradation of soil and water. Cutting of forest to build houses and cultivate land led to increased erosion of soil. The historical civilization made man adverse towards nature.

The geological conservation mainly deals with the management of the earth's surfac and sub surface resources such as soils, water, minerals and fuels. Conservation essential for the sustainable development of mankind. Along with conservation ma has to develop new strategies and device new material that are equal or better than those which have been destroyed.

The important physical systems are the minerals and rocks, weathering, soils, gravity movements, running water, coastal systems and groundwater, wind etc. Minerals are naturally occurring inorganic elements or compounds with definite chemical and physical properties. Rocks are the aggregates of minerals. Weathering is process by which soils are forming. Physical disintegration and chemical decomposition of rocks is called weathering. Soils are the upper loosely connected portion of the earth. Most of the land is covered with soils except glaciers, oceans, bed rock exposures of hills. The downslope movement of earth material due to gravity is called gravity movements, which are universal. Streams are the running water. Coastal systems are highly complex because land water interface is subjected to forces of both land and coastal waters. Groundwater is part of subsurface water occurs in all interconnected voids in the rocks. The movement of air in atmosphere is called wind. All these physical systems of environmental geoscience are causing environmental degradation with the human interference.

2.5. CHECK YOUR PROGRESS : MODEL ANSWERS

1. In the agriculture processes due to high evaporation of irrigated water generally leaves salt residue in the soils, which destroys soil fertility.
2. Urban pollution is due to waste water, sewage waters and drainage waters.
3. Minerals are the naturally occurring inorganic elements with definite chemical composition, where as rocks are the aggregates of minerals.
4. Weathering is the physical designtigration and chemical decomposition of rock materials with the effect of temperature, frost, organic life, gravity and chemicals.
5. Creep is the slow gravity movement of surface material where as subsidence is the total vertical displacement of materials.
6. In influent streams water recharges groundwater from the stream whereas in effluent stream water recharges from groundwater to stream.

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2.6. MODEL EXAMINATION QUESTIONS

I. Answer the following in about 30 lines each.

1. Explain the relation between man and nature.
2. Write about geologic conservation.
3. Write an essay on physical systems of geology in environment.

II. Answer the following in about 10 lines each.

1. Write about the ancient world.
2. Ground water - physical system
3. Gravity movements - physical systems.

Dr. P. Madhusudhana Reddy

UNIT-3: ATMOSPHERE-HYDROSPHERE, THERMAL ENVIRONMENTS OF EARTH'S SURFACE

Contents

3.1. Objectives
3.2. Introduction
3.3. Composition and Structure of Atmosphere
  3.3.1. Composition of Atmosphere
  3.3.2. Structure of Atmosphere
  3.3.3. Hydrosphere
3.4. Thermal Environment of the Earth's Surface
  3.4.1. The Heat Balance Equation
  3.4.2. Energy Absorption by Water Layers
  3.4.3. Sea Surface Temperatures
  3.4.4. Thermal Extremes near the Ground
3.5. Atmospheric Energy Releases
  3.5.1. Condensation and the Adiabatic Process
  3.5.2. Types of Energy Systems
3.6. Summary
3.7. Check Your Progress : Model answers
3.8. Model Examination Questions

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3.1. OBJECTIVES

After going through this unit, you will be able to :

* explain the different layers of environment.
* describe the composition and structure of the atmosphere.
* define various components of hydrosphere.
* describe the concepts of energy absorption of heat balance.
* explain temperature variations on the surface of sea and the principles of atmospheric energy releases.

3.2. INTRODUCTION

The environment occupies three dimensional space and extends through time and is termed as **biosphere** globally. The biosphere is the sphere in which living things exist and consists of three main components, namely, LITHOSPHERE, HYDROSPHERE AND ATMOSPHERE.

Lithosphere comprises the solid components of the environment and supplies the soil on which plants grow. It also provides most of the minerals required by the plants for their metabolism. **Hydrosphere** comprises waterly habitants and covers about 73% of earth's surface in the form of rivers, streams and oceans. Water is a vital constituent of the living matter, the only source of hydrogen element and one of the major sources

of oxygen in plant metabolism. The **Atmosphere** constitutes the gaseous and particulate matter, which envelopes the universe, and also oxygen, carbondioxide, sulphurdioxide, nitrogen and hydrogen and important constituents which influence and modify the life and light.

3.3. COMPOSITION AND STRUCTURE OF ATMOSPHERE

3.3.1. Composition of Atmosphere

The atmosphere is a thick gaseous envelope which surrounds the earth from all sides and is attached to the earth's surface by gravitational force. The atmosphere is a significant component of the biosphere ecosystem with life on the earth's surface, otherwise the earth would have become barren like moon. The atmosphere is composed of a] gases b] water vapour and c] particulates.

Gases : Nitrogen [78%] and oxygen [21%] are major gases which constitute 99% of the total gaseous composition of the atmosphere. The remaining one per cent is represented by argan, carbondioxide, neon, helium, ozone, hydrogen etc. Oxygen is very important gas for living organisms and combustion of burning matter. Nitrogen acts as dilutent and is generally inactive. Carbondioxide is used by green plants for photosynthesis. The CO_2 is also called as a greenhouse gas. Ozone gas absorbs most of the ultra-violet rays radiated from the sun and thus prevents the earth from becoming too hot.

Water vapour : Water vapour is very important constituent of the atmosphere and the content of it ranges between zero and five per cent by volume. The atmospheric vapour is received through the evaporation of moisture and water from the water bodies, vegetation and soil covers. The moisture content in the atmosphere creates several forms of condensation and precipitation eg. clouds, fog, due, rainfall, fro, hailstrom, ice, snowfall etc.

Particulate matter : The soil particles present in the atmosphere include dust particles, salt particles, pollen, smoke and volcanic ashes etc. Most of the solid particles are kept in suspension in the atmosphere. These particulates help in the scattering of solar radiation which adds varied charming colour of red and orange at sunrise and sunset. The sky appears blue in colour due to selective rayleigh scattering of solar radiation by dust particles.

Check Your Progress 1 & 2

1. What is the atmosphere ?
2. Which are the major gases in atmosphere ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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3.3.2. Structure of Atmosphere

On the basis of the characteristics of temperature and air pressure there are four layers from the earth's surface. They are, namely, Troposphere, Stratosphere, Mesosphere and Thermosphere.

Fig. 3.1 indicates the stratification of the atmosphere according to Bary and Chorley and Fig. 3.1B explains the stratification of the atmosphere according to A.N. Strolle The four layers from the earth's surface upward are explained below.

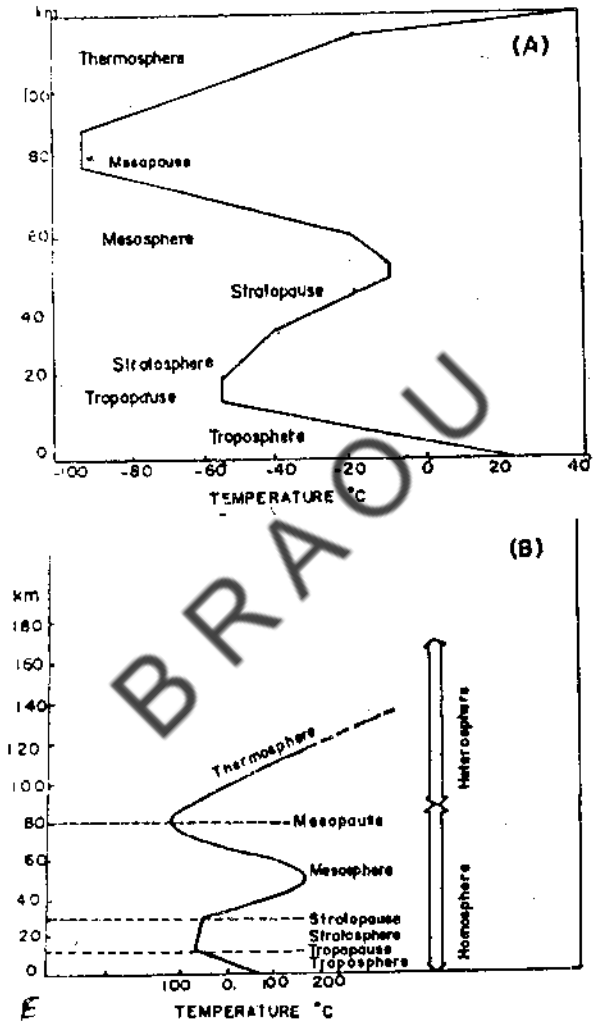

Fig 3.1. Stratification of the Atmosphere
(A) According to Bary & Chorley (B) According to A.N. Strahler

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Troposphere : The lowermost layer of the atmosphere is known as troposphere and is the most important layer because almost all of the weather phenomena occur in this layer. The word troposphere literally means "zone of region of mixing". The troposphere is of utmost significance for all the life forms including man in the biosphere ecosystem because they are concentrated in the lowest part of the atmosphere. Temperature decreases with increasing height at the rate of 6.5% per 1000m. This rate of decrease of temperature is called normal lapse rate. The height of

troposphere changes from equator towards the poles [decrease] and from the season of a year to other season [increase during summer while it decreases]. The average height of the troposphere is about 16 km. over the equator and 6 km. over the poles. The upper limit of the troposphere is called tropopause which is about 15 km thick. The word tropopause means "where the mixing stops".

Stratosphere : The layer just above the troposphere is called stratosphere but there is contrasting opinion about it's thickness. On an average the upper limit of the stratosphere is taken to be 5 km. The upper limit of the stratosphere is known as stratopause and the lower portion of the stratosphere having maximum concentration of ozone is called oxonosphere. This would cause global warming, acid rain, melting of continental glaciers and rise in sea-level, skin cancer to white-skinned people, poisonous smogs, decrease in photosynthesis, ecological disaster and ecosystem instability.

Mesosphere : Mesosphere extends between 50 km. and 80 km. Temperature again decreases with increasing height. Infact, the rise in temperature with increasing height in the stratosphere stops at stratopause. At the uppermost limit of mesosphere [80 km] temperature becomes-80°C. This limit is called mesopause above which temperature increases with increasing height.

Thermosphere : The part of the atmosphere beyond mesopause is known as thermosphere wherein temperature at its upper limit becomes 1,700°C. and is not possible to measure by ordinary temperature thermometer. It is divided into layers [a] inosphere and [b] Exosphere. Inosphere extends from 80 km. to 640 kms. and exosphere represents the uppermost layer of the atmosphere.

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Check Your Progress 3 & 4

3. Give the chronological order of atmospheric layers ?
4. What is the impact of Ozone layer splitting ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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3.3.3. Hydrosphere

Hydrosphere is a generalized work for the total free water of the earth and is largely represented by the world ocean. Using the term world ocean to refer to the combined ocean bodies and seas of the globe, let us consider some statistics in order to emphasize the enormous extend and bulk of this great salt water layer. The world ocean covers about 71% of the globe, its average depth is about 12,000 ft. [3,800 m]. The total volume of the world ocean is about 317 million cumecs [1.4 billion cu. km.] which comprises just over 97% of the world's free water.

About three-fourth of the globe is covered by hydrosphere. Out of the total surface area of the globe [505,950,000 sq.km.] lithosphere and hydrosphere covers

361,060,000 sq.km. [about 71 per cent] and 148,890,000 sq.km. [about 29 per cent] respectively. The hydrosphere is divided on the basis of size and location into oceans, inland seas, small enclosed seas, bays etc. The Pacific ocean, the Atlantic ocean and the Indian ocean are important among the oceans. The ocean basins are characterised by relief zones, namely, continental shelves, continental slopes, deep sea plains and oceanic trenches.

3.4. THERMAL ENVIRONMENTS OF EARTH'S SURFACE

In this section, we investigate the exchanges of energy across the interfaces between the lower atmosphere and solid land. Temperature of the air, the soil, or the surface waters of oceans, lakes and streams is a measure of the heat energy level. Organisms require a favourable temperature range for growth and survival. Consequently the range of surface temperature from the equator to poles, and within daily and seasonal cycles is of vital concern to the environment.

Temperature Gradient : Conducted heat travels from a region of higher temperature to a region of lower temperature is called the temperature gradient. The rate of heat flow increase as temperature gradient increases. Heat and temperature are different as heat is a measure of the total quantity of matter and temperature is a measure of the intensity level of internal energy.

Check Your Progress 5 & 6

5. What is temperature gradient ?
6. Decreasing of pressure of the air results ?

Note : (a) Write your answers in the space given below.
(b) Compare your answers with the model answers given at the end of this unit.

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3.4.1. The Heat Balance Equation

Making use of the principles of heat transport and exchange, let us set down the various terms that describe the heat balance by applying a column of soil or water. This column has a cross section of unit area. Its upper limit is the surface of the soil or water in contact with the atmosphere. The column depth is indefinite, but sufficient to reach a region where exchanges of heat are close to zero, the balance equation of heat exchange is :

$$G = R - H - LE - F$$

Where 'R' is net radiation at the upper surface

'H' is flux of sensible heat upward through the surface into the atmosphere

'LE' is the latent heat flux by evaporation of water from the upper surface and

'F' is horizontal flux of heat into or out of the column by conduction.

Since the net radiation, 'R' represents the basic energy source for the whole system, it is best to rearrange the terms of the equation, thus :

$$R = H + LE + G + F$$

Fig. 3.2 explains these four terms on the right side of the equation. Each of these terms has a positive value when heat is entering the column, a negative when leaving. The horizontal heat flux 'F' will be practically zero for soil or rock since there is no motion of the solid matter. The heat balance equation applies for any given time span, such as the second, minute, hour, day or year.

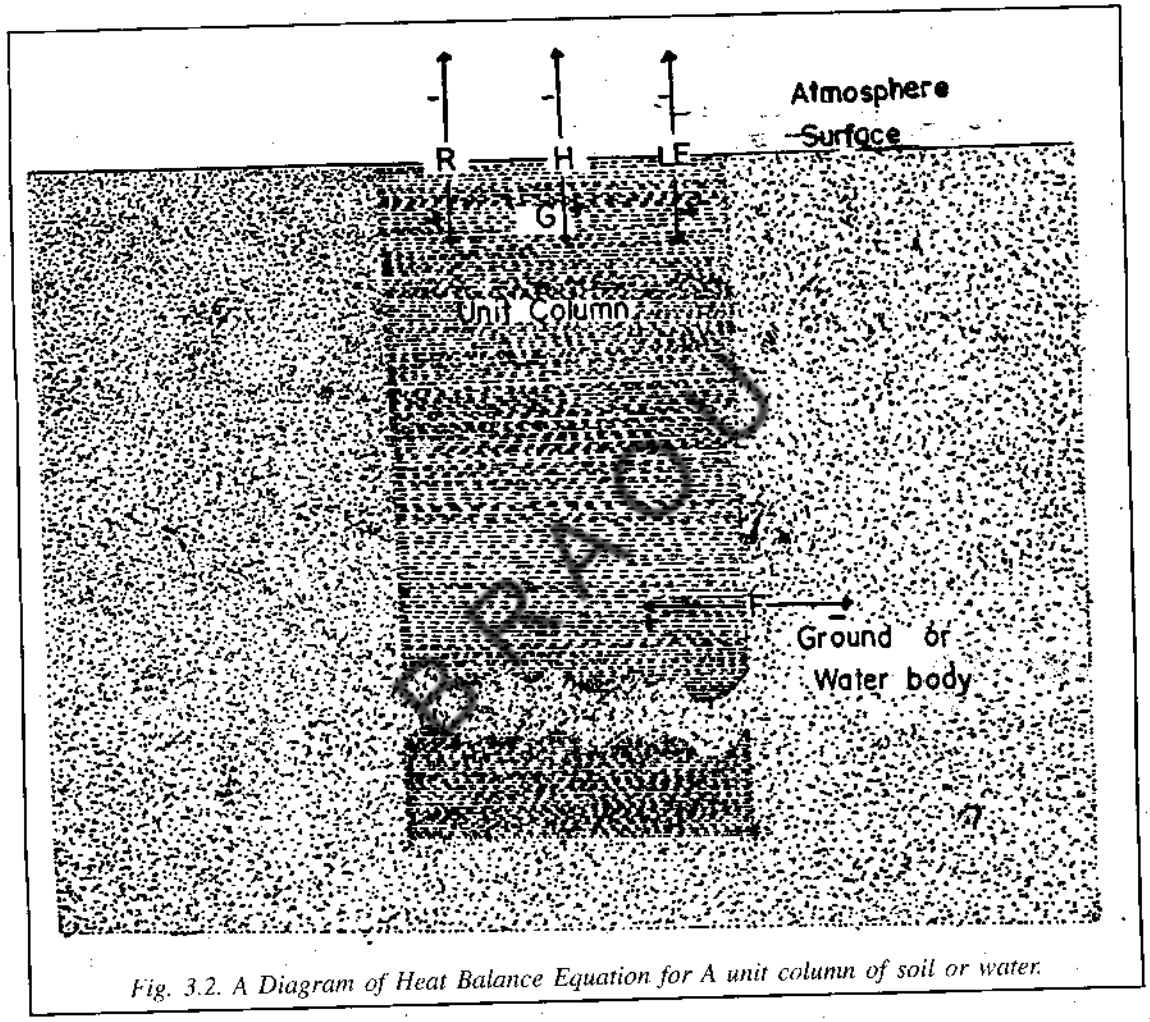

Fig. 3.2. A Diagram of Heat Balance Equation for A unit column of soil or water.

3.4.2. Energy absorption by Water Layers

Energy that is not reflected is transmitted through the upper zone of the water and is gradually absorbed, raising the temperature of the water. This energy is called as thermal energy. Fig. 3.3 shows how the solar energy spectrum is depleted as the rays pass down to greater depths. Notice that most of the infrared energy within the solar spectrum is absorbed within the top 4 in. [0.1 m] while at a depth of 40 in. [1m.] only the ultraviolet and visible wavelengths remain. Consequently, the warming process is concentrated in a very shallow surface layer, largely by absorption of infrared rays. The blue-green colour of clear water bodies is explained by the fact that the blue and green wave lengths are easily scattered back to the eye, whereas the yellow and red wave lengths are absorbed without reflection.

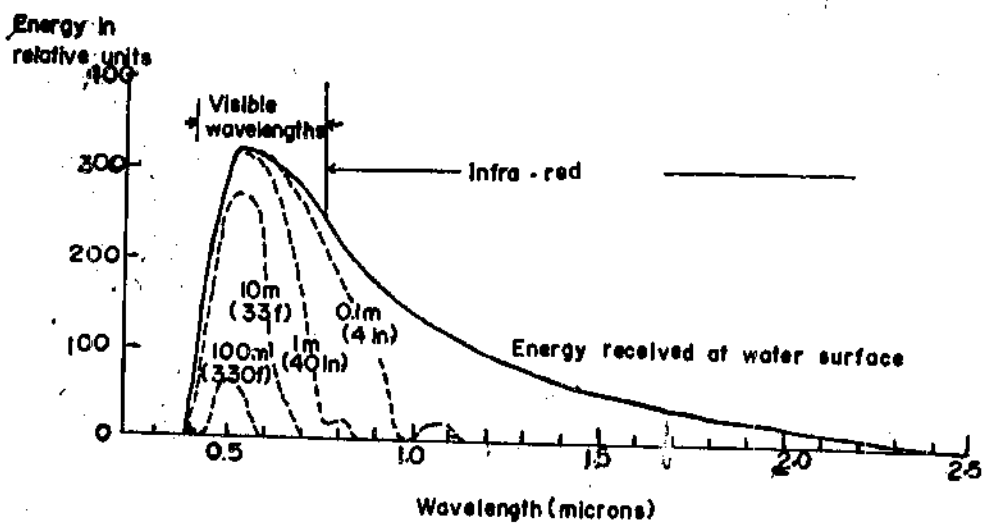

Fig. 3.3. The Solar Radiation Spectrum at various depths below the surface in pure, fresh water.

3.4.3. Sea Surface Temperatures

Thermal environments of the ocean surface are summarised on a global basin by two maps, one showing surface-water temperatures for August, the other for February. Because a positive radiation balance at the sea surface continues to add heat to the sea surface during summer period, sea surface reach their maximum temperatures in middle and high latitudes during the month of August. Correspondingly, there is a continuing loss of heat during the winter period, so that February seas the lowest surface-water temperatures. Lines of equal temperatures called as isotherms. The isotherms trend east-to-west around the globe with maximum values in a low latitude belt and strong pollward decline both north and south. Large areas of equatorial oceans maintain a surface temperature higher than 80°F. [26°C.].

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Life-forms are strongly responsive to the world distribution of ocean water temperatures. For example, the reef-building corals require temperatures at least as high as 68°F. [20°C] and usually between 77°F. and 86°F. [25°C. and 30°C.]. As a result, coral reefs are limited to a latitude zone between 25 deg. south and 30 deg. north. Because of these changes in temperatures, invertebrate marine animals show a much greater diversity of species in warm low-latitude waters than a coldwater of Arctic coasts. Production rates of minute floating organisms like plankton are also influenced by water temperatures.

3.4.4. Thermal Extremes near the Ground

Fig. 3.4 shows temperature profiles observe through a range of height above the ground surface and depths into the soil. These observations are the averages for the months of July and August. An observation of these temperature profiles revealed that the ground surface and the shallow layers of air and soil immediately adjacent to it constitute a severe thermal environment for plants and animals subjected to its stresses.

Conditions at tree-top height in a forest, and in the lower root zone of the soil are much more moderate in terms of temperature extremes.

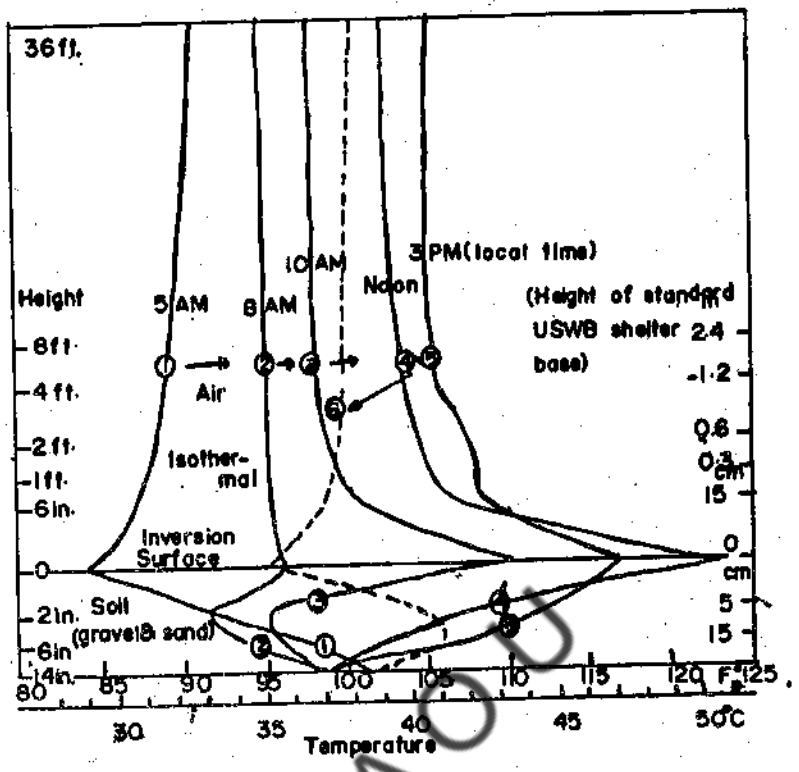

Fig. 3.4. Air and soil temperatures at various levels above and below the ground surface throughout the day and night

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In the relationship of altitude to radiation and the thermal environment, the important points are that while the average air temperature falls with increasing altitude, the intensity of both incoming and outgoing radiation of energy show a strong increase. You might be tempted to say that climbing to a higher altitude near the equator is like travelling from the equator to the poles.

3.5. ATMOSPHERIC ENERGY RELEASES

The subject atmospheric energy releases is mainly deals with the planetary water balance which depends upon large-scale condensation of water vapour. The condensation is the proceses in which the latent heat is transformed into sensible heat. Condensation occurs with high intensity in relatively small volumes of air, as compared with the slow evaporation of water into the troposphere over vast surfaces of oceans and lands. The effect of this concentration of condensation is to infuse the atmosphere locally with of sensible heat that may be converted into kinetic energy. These events are storms and related weather disturbances in which winds and vertical air motions powered by condensation may be very intense. Condensation may lead to precipitation in the form of rain, snow, hail or sleet. Not only does precipitation provides fresh water vital to organise processes at the land surfaces, but it may be accompanied by storm winds that act as a strong environmental stress and at times as a real hazard, bringing whole sale

loss of life to animals as well as the physical distinction of larger plants. In studying condensation, we shall consider or encounter another basic principle of physics of heat, namely, that the expansion of rising air is accompanied by cooling of that air, while contraction of sinking air into a smaller volume is accompanied by heating of the air. This principle is behind the adiabatic process and is vital to changes in state of water by describing the contaminant of water vapour in the air.

3.5.1. Condensation and the Adiabatic Process

Falling rain, snow, sleet or hail, referred to collectively as precipitation. This results only where large masses of air are experiencing a steady drop in temperature below the dew point. This condition can not be brought about by the simple process of chilling of the air through loss of heat by conduction and by longwave radiation during the night. One of the most important laws of meterology is that rising air experiences a drop in temperature, even though no heat energy is lost to the outside [Fig. 3.5]. The drop of temperature is a result of the decrease in air pressure at higher elevations, permitting the rising air to expand. Individual molecules of the gas are more widely diffused and donot strike one another so frequently so that the gas has a lower sensible temperature. Temperature change due to volume change only, and without import or export of heat is described as a adibatic change.

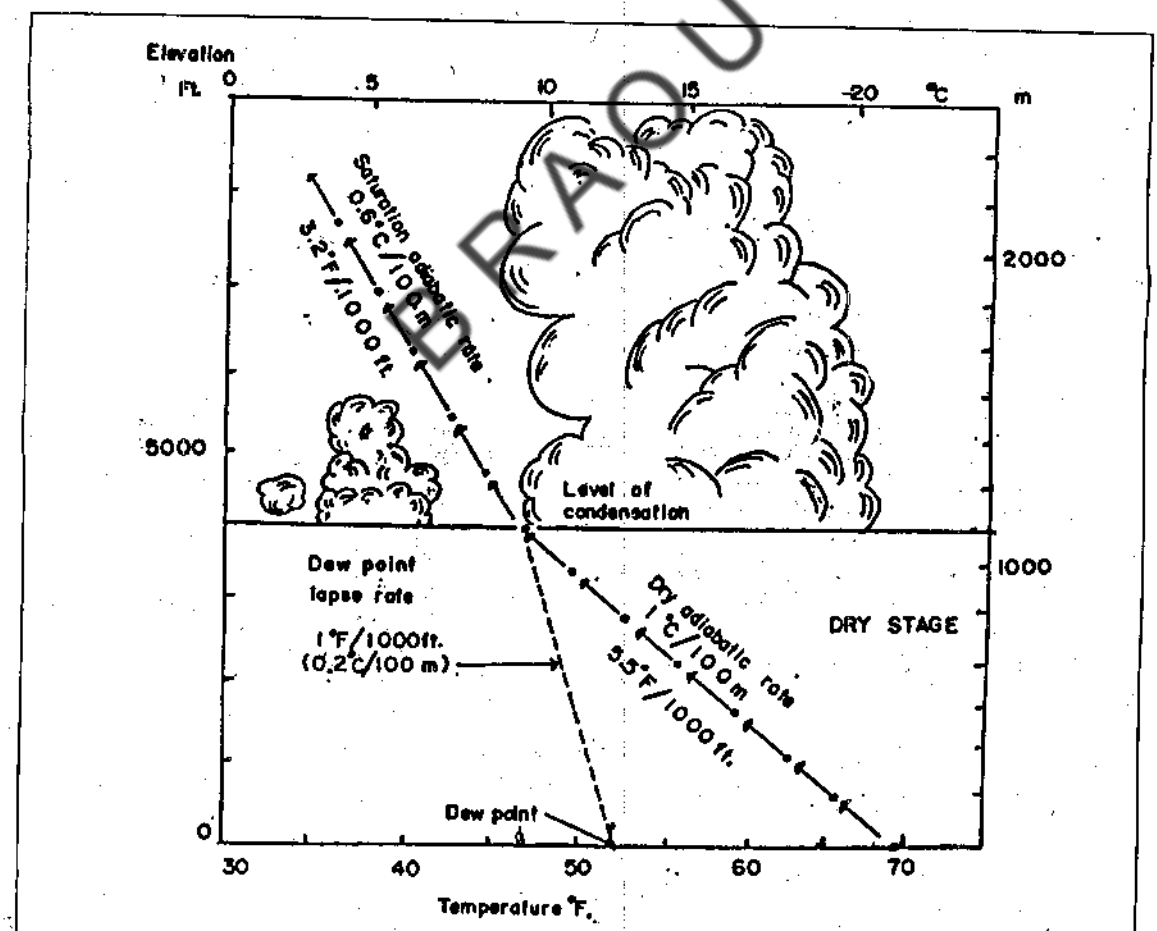

Fig. 3.5. Adiabatic Changes of temperature in a rising air mass

Dry adiabatic rate is defined as the rate of drop of temperature when no condendsation occurred. When water vapour in the air is condensing, the adiabatic rate is less, owing

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to the partial counteraction of temperature loss through the liberation of latent heat during the condensation process. The modified rate is called as wet adiabatic or saturation adiabatic rate.

3.5.2. Types of Energy Release Systems

The atmosphere and oceans illustrate all three types energy systmes, namely,

1. The sun-to-earth radiation system, i.e. Electromagnetic energy system.
2. The daily and seasonal rhythms of radiation and heat. Atmosphere and oceans respond completely predictable rhythmic changes in the transport and storage of energy and matter.
3. The energy produced due to irregular-timed fluctuations in the flow of fluids, due to their characteristic instability.

Energy transport and transformation has been the predominant concern and found that air and water are the forms of matter whose transport provides the pathways of those energy fluxes. Water, in particular, is the key to understanding of the parthways of energy, because water undergoes changes of state and is capable of energy storage and transport in vast quantities as latent heat. Heat and water, which have been traced through many environmental controls of the life on earth.

3.6. SUMMARY

The environment occupies Biosphere globally, consists of three main components namely Lithosphere, Hydrosphere and Atmosphere. Lithosphere comprises the solid components of environments and supplying soil on which plants grow. Hydrophere comprises with water and 73% of earth surface is covered by this. Atmosphere consists of the gasious and particulate matter which surrounds the earth from all sides and is attached to earth by gravitational force. Nitrogen (78%) oxygen (21%) are major gases of atmosphere. Water vapour is also important content of atmosphere the other one particulate matter of atmosphere consists of dust particles, salt particles, pollen smoke and volcanic ashes etc. The four layers of atmosphere are troposhere, stratosphere, mesosphere and thermosphere. Troposphere is the lowest most layer where weather phenomenon occurs. The average thickness of this layer is 16 km. above equator and 6 km. near poles. The upper limit is the tropopause. Stratosphere follows troposhere and the upper limit of stratosphere from earth surface is 50 km. Mesorphere extends 50 to 80 km. from earth surface. The upper level of this layer is called mesopause and contains 80°C temperature. The portion above the mesopause is the thermosphere and is devided into inosphere and mesosphere. Inosphere extends from 80 to 640 Km. and exosphere extends beyond 640 kms. and represents the uppermost layer of atmosphere.

Thermal environments of earth surface are vital for the growth and survival of organisms. Thermal gradient is a process by which conducted heat travels from the regions of higher temperatures to lower areas. Heat is a measure of total quantity of matter and temperature is measure of the intensity level of real energy. The heat balance equation is G = R - H - LE - F where G is the radiation, H is the flux of sensible heat moving into atmosphere, LE is the latent heat, and F is the horizontal flux of heat.

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Energy that is not reflected is transmitted through the upper zone of water individually absorbed, rising the temperature of water which is called as thermal energy. The blue - green colour of clear water examined by the fact that the wave lengths of the above two colours can easily scattered, where as the yellow and red are simply absorbed by water. Sea surface temperature is generally increases in summer and decreases in winter. Production rates of minute organisms are influenced by change of sea water temperatures. The temperature changes in the ground surface depending the areas and altitudes.

Atmospheric energy release is mainly deals with planetary water balance, which depends upon large scale condensation of water vapour. The drop in temperature is due to rising air . If this excess due point, rain, snow fall or hail, will occur as precipitation Energy transport and transformation has been predominent and found that air and water are the forms of matter. Water is the key in understanding the path ways of energy. Heat and water are having many environmental controls of the life on earth.

3.7. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Atmosphere is a thick gaseous envelope which surrounds the earth from all sides and is to the earth's surface by gravitational force.
2. Major gases are Nitrogen [78%] and Oxygen [21%]
3. The chronological order of atmospheric layers from the ground is : (1) Troposphere, (2) Stratosphere, (3) Mesosphere, (4) Thermosphere.
4. It causes ecological disaster and ecosystem instability.
5. Conducted heat travels from region of higher temperature to region of lower temperature.
6. Drop in temperature.

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3.8. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Describe the structure and composition of atmosphere.
2. Explain thermal environments of the earth's surface.
3. Write notes on atmospheric energy releases.

II. Answer the following questions in about 10 lines each.

1. Classify different layers of environment.
2. Give brief discussion on Hydrosphere.
3. Explain the heat balance euqation.
4. Describe sea surface temperatures.
5. Explain thermal extremes near the ground.
6. Write briefly atmospheric energy releases.
7. Classify the types of energy systems.
8. Describe condensation and adiabatic process.

Dr. M. Anji Reddy

UNIT-4: MAN'S IMPACT ON ATMOSPHERE

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4.6. Urbanization and Balances of Radiation and Heat
4.7. Pollutants in Atmosphere
4.8. Harmful Effects of Atmospheric Pollutants
4.9. Summary
4.10. Check Your Progress : Model Answers
4.11. Model Examination Questions

4.1. OBJECTIVES

After studying this unit, you should be able to :

* explain the role of CO_2 and oxygen levels in the atmosphere and the concepts of Man-Induced changes in atmospheric water vapour, clouds and precipitation,
* define the effects of urbanization and pollutants on atmosphere,
* describe the harmful effects of pollutants in the atmosphere.

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4.2. INTRODUCTION

This unit, namely "Man's impact on atmosphere" will attempt a sober and caution evaluation of the effects of man's activities upon the atmosphere, since the basic scientific principles of atmospheric science and of the interactions between atmosphere and oceans and between atmosphere and lands are well known. Atmospheric changes induced by man fall into four categories :

1. Changes in concentrations of the natural component gases of the lower temperature.
2. Changes in the water vapour content of the troposphere and stratosphere.
3. Alteration of surface characteristics of the land and oceans in such a way as to change the interaction between the atmosphere and those surfaces.
4. Introduction of finely divided solids into the lower atmosphere, alongwith gases not normally found in substantial amounts in the unpolluted atmosphere.

4.3. CARBONDIOXIDE AND OXYGEN LEVELS IN ATMOSPHERE

From the environmental stand point atmospheric carbondioxide and free molecular oxygen [O_2] are the most critical of the natural constituents of pure and dry air. CO_2 is critical because it is an absorber and emitter of longwave radiation as well as a vital

compound in plant growth and O_2 because it is chemically very active and plays an essential role in both organic and inorganic processes of life layer. Both atmospheric carbon as CO_2 and O_2 are involved in continuous cycles of interchange between atmosphere, and oceans, soil and rock layers, and the biosphere. Both land and marine plants withdraw and use CO_2 to create carbohydrate compounds of plant tissues. Animals consume plants, releasing CO_2 back to the atmosphere in the process of biological obligation [respiration]. Decomposition of plant matter also releases CO_2 to the atmosphere. The recycling of CO_2 by organic processes also involves inputs and outputs of energy.

From the long-range point of view throughout the earth's long history carbon and oxygen [as CO_2 and H_2O] have been added to the atmosphere by out gassing from the earth's interior. The environmental effects to be anticipated from an increase of atmospheric CO_2, because CO_2 is an absorber and emitter of longwave radiation, its presence in larger proportions will raise the level of absorption of both incoming and outgoing radiation, changing the energy balance so as to raise the average level of sensible heat in the atmospheric column.

4.4. CO_2 AND GREENHOUSE EFFECT

The presence of CO_2 generated by burning of fuels and by various industries has a great impact on the global climate. The amount of CO_2 has been rising steadily at an exponential rate of 4% per decade from 270 + of - 10 ppm [Fig. 4.1]. The gas CO_2 while it lets the sunlight enter the atmosphere, inhibits or prevents the heat rays [infrared] from returning back to the sky and thus causes a warming up of the atmosphere [Fig. 4.2]. This is called the greenhouse effect of CO_2. The warming up of the earth will begin to be felt in the 1990's . Table 4.1 shows the increase in CO_2 in the atmosphere and rise of average temperature on the earth's surface. The average temperature increase will be of the order of 2°C by AD 2050 and 5°C by 2100s. Significantly, in the polar regions the increase would be two to three times as much, which would cause rapid melting of the ice caps.

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Table 4.1. Increase in CO_2 content in Atmosphere and Rise of Average Temperature on the Earth's Surface.

Year	Global Concentration of CO_2 (ppm)	Average Temperature Rise (°C)
1960	285	
1980	293	0.5 - 0.8
1967	320	
1970	330	0.1 - 0.2
1980	335	
2000	380 (375 - 384)	
2050		2
2100		3 - 4.5

(Based on data from B. Hileman, 1982, and others)

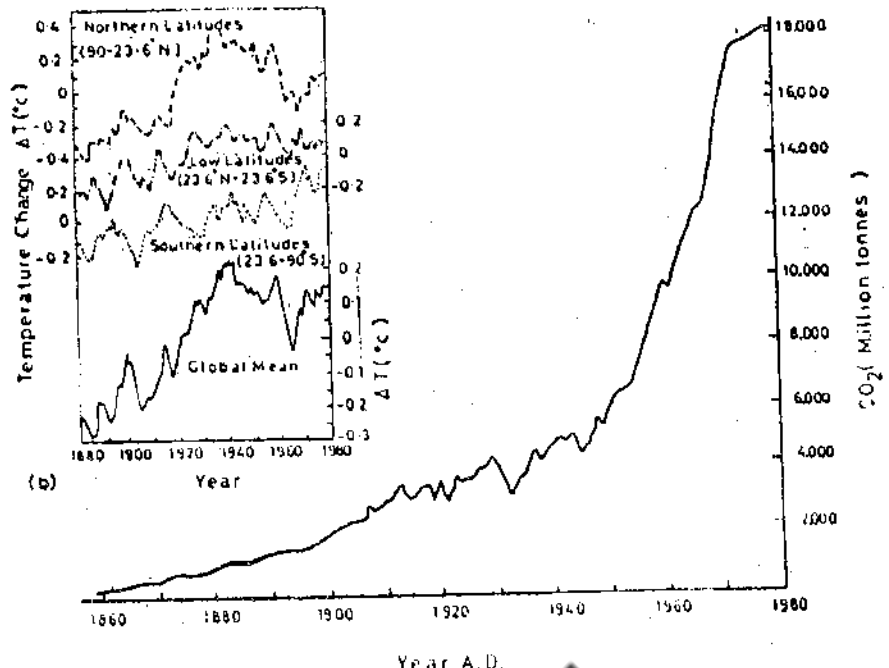

Fig. 4.1. (a) The CO_2 content in the atmosphere has been steadily rising due to various human activities, primarily industrial ventures. (After Holgate et. al., 1982 Fig. 2-9) (b) The trend of mean atmospheric temperature resulting from an increase in CO_2. Note that the temperature rise is two to three times greater in the higher-latitude polar belts. This have a great impact on the melting of polar ice. (After E.El-Hinnawi and A.K. Biswas (Ed.), 1981, Renewable Sources of Energy and the Environment, Tycooly, Dublin, 219 p., Fig. 3)

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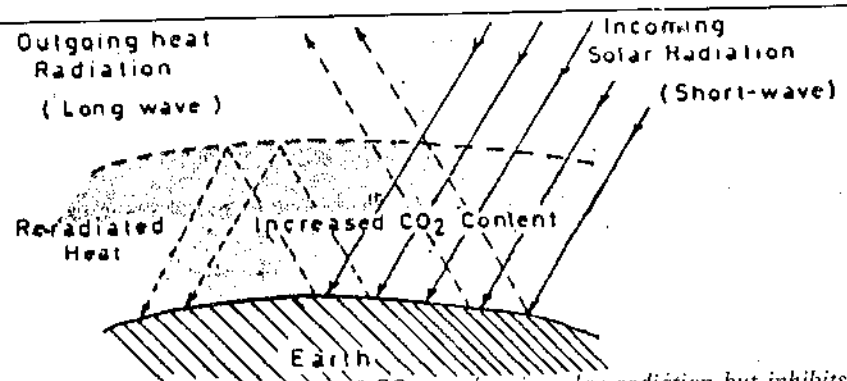

Fig. 4.2. The greenhouse effect of CO_2 gas lets in solar radiation but inhibits or prevents the escape of reflected heat, resulting in warming up of the air.

Large scale deforestation has greatly contributed to the rise of CO_2 content in the air, The plants consume a considerable amount of CO_2 to generate oxygen through the process of photosynthesis or carbon assimilation. With less than a third of land left

with forest cover, it is inevitable that the atmosphere is beginning to show a steep rise in CO_2 content. Since the oceanic water is also warming up, its capacity to dissolve and hold CO_2 in captivity is also diminishing.

Check Your Progress 1 & 2

1. What is Greenhouse effect ?
2. Is there any impact in polar regions with greenhouse effect ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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4.5. MAN-INDUCED CHANGES IN ATMOSPHERIC WATER VAPOUR; CLOUDS AND PRECIPITATION

Like CO_2, water vapour in the atmosphere plays a vital role in the radiation and heat balances through its capacity to absorb and emit longwave radiation. Because the capacity of air to hold water vapour increases with temperature, an overall global rise of air temperature, would be expected to result in a larger storage of water vapour in the global atmosphere. It seems reasonable that there would also be increased precipitation, the average air temperature was lowered substantially. The tropical deserts underwent an equatorward expansion, while the wet equatorial belt was correspondingly narrowed. This evidence suggests that reduced air temperature was associated with reduced precipitation generally in low latitudes, and this effect is in line with our deductive reasoning.

A considerable quantity of water vapour enters the atmosphere from the surfaces of lands. Man's agricultural activities have been altering the surface characteristics of the lands through deforestation and the maintenance of large areas in crop cultivation. Further such surface alterations is to change the rate of evapotranspiration. Complete removal of a dense forest cover will sharply reduce the quantity of water returning to the atmosphere in vapour form. Surface changes made by man have had upon the moisture properties of air masses of great vertical extent is uncertain, although we know that climate near the ground is profoundly influenced by agricultural development and urbanization.

4.6. URBANIZATION AND THE BALANCES OF RADIATION AND HEAT

In the urban environment the absorption of solar radiation causes higher ground temperatures for two reasons :

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1. Foliage of plants is absent, so that the full quantity of solar energy falls upon the bare ground. Absence of foliage also means absence transpiration, which elsewhere produces a cooling of the lower air layer through the latent heat flux.

2. The roofs and pavements of concrete and asphalt hold no moisture and evaporative cooling does not occur as it would from a moist soil. The thermal effect is that of converting the city into a hot desert.

The surface heat is conducted into the ground and stored there. The thermal effects within a city are actually more intense than on a sandy desert floor, because the capacity of solid concrete, stone or asphalt to conduct and hold heat is greater than that of looser, sandy soil. The impact of man's various activities is greatest in cities. The four factors make the cities warmer upto 10^0C more than the country side are

1. Energy generation and release of waste heat
2. Concrete buildings, asphalt pavements and roads that trap heat
3. Obstruction in the circulation of breeze and wind.
4. Presence of pollutants in concentrated form.

Check Your Progress 3 & 4

3. What are the main causes of reducing water vapour in the atmosphere ?
4. Why cities are warmer than villages ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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4.7. POLLUTANTS IN ATMOSPHERE

The man has degraded the quality of the lower atmosphere over densely polluted sections of the industrial nations is so obvious to the senses that the statement needs no proof. Industrial activities and related practices of populations in industrial regions inject into the atmosphere, two classes of contaminants or pollutants, namely,

1. There are solid and liquid particles called as particulate matter.
2. There are compounds in the gaseous state that are included general terms chemical pollutants.

The most common types of pollutants are NO_2, CO_2, CH_4, NH_3, H_2S, Cl_2, SO_2 and other volatile hydrocarbons and particles of carbon and tiny drops of water called aerosols. The amount of pollutants discharged into atmosphere will cause formation of acid rains and various sources of air pollution.

Check Your Progress 5

5. What are the main contaminants in the atmosphere?

Note : (a) Write your answers in the space given below.

(b) Compare your answer with the model answer given at the end of this unit.

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4.8. HARMFUL EFFECTS OF ATMOSPHERIC POLLUTANTS

Atmospheric pollution effects climate on the surface of the earth particularly the microclimate of the affected areas. Breathing problems and respiratory ailments are the more serious consequences. For humans in cities both sulphur dioxide and hydrocarbon compounds altered by photochemical reaction to produce H_2 SO_4 and etylene respectively are irritants to the eyes and respiratory system. Nitrogen dioxide is also an eye and lung irritant when present in sufficient quantity. Photochemical alteration of nitrogen oxides leads to ozone, which acts as irritant in smog and would be lethal if it occurred in large concentrations. For persons suffering from respiratory ailments such as brauchitis and emphysema, the breathing of heavily polluted air can bring on disability and even death. Then is also a suspected linkage between breathing of atmospheric pollutants and lung cancer, since the incidence is higher in cities than in other areas.

Carbon monoxide is a cause of death when inhaled in sufficient quantities. When breathed in a closed garage the carbon monoxide from automobile exhaust will kill the person. Ozone in urban smog is more deleterious effect on plant tissues and some times even kills the ornamental plants. SO_2 is in serious to certain plants. Atmospheric sulphuric acid in cities has in places largely wiped out lichen growth. Radio active pollutants in atmosphere causes genetic damage to plant and animal tissues exposed to ionisation radiation, lead and other toxic metals are particular source of human health in the future. Not the least of the economic losses from pollution are simply from soilage of clothing, automobiles, furniture and interior floors, walls, and cealings.

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4.9. SUMMARY

Man's impact on atmosphere is mainly of changes in concentrations of gases, changes in water vapour content, alteration of surface character of land and oceans and introduction of pollutant particles into atmosphere. CO_2 and O_2 are very important constituents of atmosphere. CO_2 is the vital compound in plant growth. O_2 has essential role in both organic and inorganic process on earth. The presence of larger proportions of CO_2 will rise the radiation and effect the environment. The CO_2 generated by burning fuel and by various industries enter the atmosphere and causes a warning up of the atmosphere, which is called the greenhouse effect. The rise of CO_2 in atmosphere by 2100 A.D. will cause rapid melting of ice in polar regions, which results a cotastropic effect on mankind. The large scale deforestation contributing the rise of CO_2 so 1/3 of the total land available must be preserved with forests.

Water vapour in atmosphere plays a vital role in the radiation and heat balance. Man's agricultural activities have been altering the surface characteristics of lands, ultimately changes the rate of evapotranspiration. The climate near the ground is influenced by agricultural development and urbanisation. Urban areas are more warmer than country side because, the urban areas are nowadays are termed as concrete jungles. The solid concrete stand or asphalt used for roads can conduct and hold more heat. The most common type of pollutants are NO_2, CO_2, NH_3, H_2S, Cl_2, SO_2 and other volatile hydrocarbon compounds. This compounds are causing more dangerous effects on the living organisms on earth.

4.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The presence of excessive CO_2 in the atmosphere prevents returning back radiation to the sky causes warming up of the atmosphere is Greenhouse effect.
2. It causes the raising of water level in oceans by melting ice caps.
3. a. Deforestation.
   b. Rapid urbanisation.
4. Because concrete buildings, roads and pavements are more and obstruction in the circulation of breeze and wind and presence of pollutants in concentrated form.
5. a. Solid and liquid particles of particulate matter.
   b. Chemical compounds in the gaseous state.

4.11. MODEL EXAMINATION QUESTIONS

I. Answer the following in about 30 lines each.

1. Describe the different types of pollutants in the atmosphere and their harmful effects.
2. Describe the impact of CO_2 on global climate with reference to greenhouse effect.

II. Answer the following in about 10 lines each.

1. Rapid industrialization changes the heat and radiation balance in the atmosphere. Specify the reasons.
2. Give an account of the changes in CO_2 and O_2 levels in the atmosphere.

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Dr. M. Anji Reddy.

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BLOCK - 2
GEOLOGICAL HAZARDS

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UNIT-5 : VOLCANOES

Contents

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5.2. Introduction
5.3. Origin
5.4. Volcanic Products
5.5. Energy, Size, Intensities, Magnitude
5.6. Classification
5.7. Occurrence & Distribution
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  5.8.1. Lavaflows
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  5.8.6. Sub-marine Volcanic Activity
5.9. Volcanic Resources
5.10. Prediction of Volcanic Erruptions
5.11. Summary
5.12. Check Your Progress : Model Answers
5.13. Model Examination Questions

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5.1. OBJECTIVES

After studying this unit, you should be able to :

* explain about natural hazards with volcanoes
* describe the origin & classification of Volcanoes
* define environmental impacts
* explain the volcanic resources
* define how volcanoes can be predicted.

5.2. INTRODUCTION

Natural hazards are those occurrences brought about by the forces of nature that cause discomfort, injury, or death to life, damage or destroy physical structures and other property; change the physical character of land, water, and air and damage or destroy the plant and animal life of the affected area. The natural hazards - volcanoes, earthquakes - cause greater damage to the human civilization. According to theories of Sea floor spreading and Plate Tectonics , these Volcanic & Earthquake belts are intimately associated with the plate margins, midoceanic ridges, hot spots and rifts.

Volcano is a vent or fissure in the surface of the earth through which magma and associated gases and ash erupt. The volcanoes on land are generally conical in shape and made up of ejected material lava and pyroclasts. Lava is the extrusive form of magma. Cater, " a basin like, rimmed structure " is mostly observed on the summit of

the volcanic cone. Caldera is a basin much larger than a crater, as well as, the vent or vents inside it. Both of these the volcanic landforms originate as a result of collapse of emptied magma chamber by explosive eruption or by rim formation with volcanic material. The 1815 A.D. Tambora volcano(Indonesia) eruption is the largest historical and known one in the last 10,000 years

5.3. ORIGIN

Lava is a molten extrusive form of magma. Magma is a "naturally occurring mobile rock material, generated within the Earth and capable of intrusion and extrusion, from which igneous rocks are thought to have been derived through solidification and related process. " As the magma moves to shallower depths, all the three phases- solids, liquid, gas - will be present in it.

The average geothermal gradient in the Earth's Crust is 25°C per km. depth. The temperatures - 800° to 1200° C are estimated at a depth of 60 to 100 km in the Earth and at that Pressure Temperature conditions rocks melt partially. This high geothermal gradient may rise near to the surface in the midoceanic ridges and in hot spot area. In subduction zone, the subducting plate also melts partially at this depth and more as it moves to greater depths. The melting depth zone is identified, by seismic activity, as a low velocity layer. The subduction zone, synonymous to the Benioff seismic zone, is identified as negative gravity anomaly belt by F.A Vening Meinesz . These two layers are the deep sources of magma for volcanoes . The magmas move upward by its own buoyancy as it will have less density than the surrounding rocks (Granite. 2.5 gm/cm^3 at 800°C; Basalt. 2.65 g/cm^3 at 1200°c) and by very small forces generated by plate movement. As the magma moves into intermediate depths the lithospheric pressure will be less resulting in increase of volume of magma as well as its gas content. The further movement to shallow depths needs escape routes - faults (rift systems) (Fig. 5.1)

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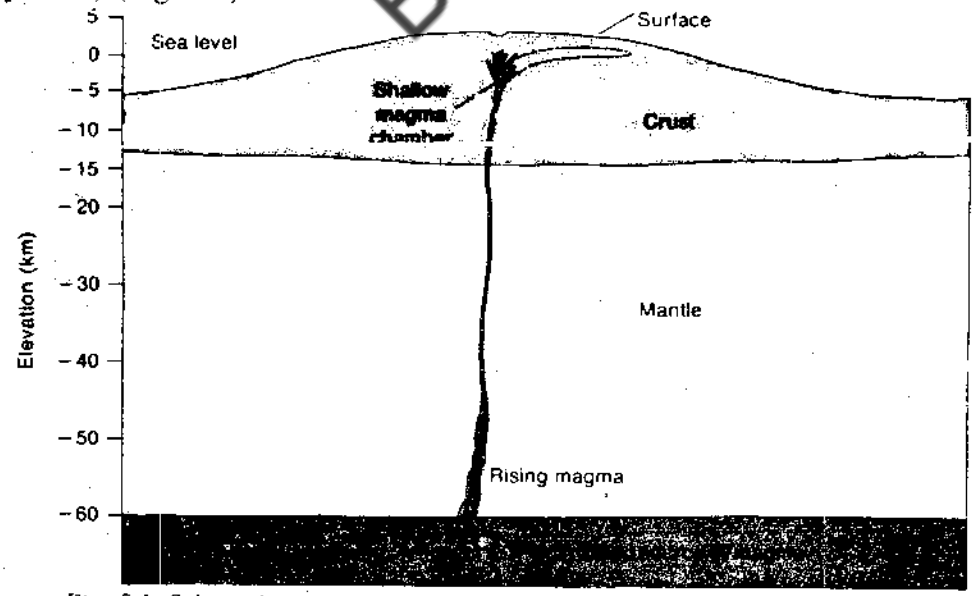

Fig. 5.1. Schematic cross section of an active Hawaiian volcano. The vertical scale is exaggerated two times. The dotted line extending to the right from the shallow magma chamber is an inferred zone of feeder dikes to a rift zone. The deep source of magma, below 50 to 60 kilometres and the shallow storage zone at 3 to 6 kilometres beneath the surface are the vital parts of the active system. (After Jerry Eaton. U.S. Geological Survey).

In the Mid-oceanic ridge, the high geothermal gradient (1200^{0}c) reaches the bottom of the oceanic crust (thickness. 5 to 10 km). The magmas becomes effusive through the fault system in the mid oceanic ridge. In the Continents, the continental crust though thick, (*35 to 60 m) because of its density and ductility, and deep faults and fracture zone, allows the buoyant magma to the surface. The upwelling heat flow also plays a significant role in the phenomenon.

Finally the viscosity of magma, which depends on SiO_2 content and other chemical constituents, gas content and temperature, controls the effusive quantity of volcanic products. The more viscous acid magmas(SiO_2>60%) than basic magmas

(SiO_2 : 44 to 52%) crystallize at shallow depths and form lopoliths, granite batholiths etc. But the basalts occupy large tracts of the earths surface(e.g. Midoceanic ridge basalts; Deccan basalts, Columbia basalts) However, the intermediate magma (SiO_2 54% - 65%) volcanoes produce large quantities of pyroclastic material as a result of explosive eruption.

5.4. VOLCANIC PRODUCTS

The volcanic products are classified, based on the physical nature, as - gases, liquids and solids (Table 5.1) At the time of eruption, they have a temperature of over 1000^{0}C. depending on the chemical composition of magma.

Table 5.1. Volcanic Products

A.	Gaseous .	1. Fumes.	2. Exhalative activity H_2O, SO_2,CO_2,HCl, H_2S,He, etc. Basaltic lavas are poor in volatile content(H_2O,<1%) and Rhyotitic lava contain abundantly(H_2O > 10%)
B :	Solids . 1. Tephra.		2. Explosive activity
	a) Pyroclastics (air fall fragments)		i.Volcanic dust(<1/16mm) ii. Volcanic ash(1/16-2 mm) iii. Volcanic cinder(2-64 mm) iv. Volcanic blocks(Solids > 64 mm) v. Volcanic bombs(Plastica > 64 mm)
	b) Pyroclastic flows		Hot fluidized flows
	c) Volcanic mud flows (Lahars)		Volcanic ash + water flows
C.	Liquids	1. Lava	2. Effusive activity
		a.aa type (Rough and bulky surface)	
		b. Pahoehoe type(smooth to ropy surface)	

Pyroclastics are associated with explosive and acid lava volcanoes. The flows are observed with ice and snow covered volcanoes and rainfall.

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In general the basic, intermediate and acid lavas are associated with effusive, mixed, and explosive eruptions, respectively. The basalts (e.g. Deccan basalts) spread hundreds and thousands of square kilometers because of high temperature, richness in Ca, Mg, Fe. The acid varieties suffer explosion due to high SiO_2. The alkaline lavas rich in Cl, F, CO_2 have very good flow characteristics . The composition of magma lava depends on the rock forming processes associated with plate motion. The lava starts solidification from 1000 to 600^0 C.

The basaltic magmas are more mobile than acid types because of high temperature and content of (Ca + Mg + Fe) and low SiO_2 and gases.

Check Your Progress 1 & 2

1. What is a Volcano ?
2. Name some of the volcanic products.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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5.5. ENERGY, SIZE, INTENSITIES, MAGNITUDES

The Earth delicately balance the energy generated and stored, and heat lost into space. Arthur Home's thermal convection current theory explain the transport of heat energy to the surface. The geothermal flux of the Earth is 10^{28} erg/year. H. Tsuya(1955) proposed a volcanic eruption scale based on a logarithmic scale of total erupted volume of the deposit. G.P.L Walker(1980) related the quantitative characterization of volume eruption to the magnitude(total erupted mass in kilograms), intensity(magma discharge rate in kilograms per second) which determine the eruption - column height for explosive eruption. C.G. Newhall and S.Self(1982) modified the Tsuya scale and proposed Volcanic Explosivity Index (VEI) based on the volume of ejecta, height or the ejecta and gas cloud above the volcano, type of activity, duration of continuous blast(hours) (table. 5.2) Sergli Fedotov(1985) suggested Volcanic Intensity(VI) based on the logarithm of energy released during eruption, as calculated from magma discharge rate, However, no single scale is sufficient to define the quantitative aspects of volcanic eruption, similarly for earthquakes, as both intensity and magnitude need consideration.

Smithosonian Institution (Washigton. D.C) published VEI magnitudes for the continental eruptions of the last 500 years. The study of volcanic eruptions of past and present revealed that number of eruptions in each category, over a given period of time, increases as the magnitude decreases.

Table 5.2. Volcanic explosivity index (VEI)

VEI	A	B	C	D	E	F
0	Non-Explosive	$<10^4$-0	< 0.1	Gentle Effusive	Negligible	None
1.	Small	$<10^4$-10^6	0.1-1.0	Effusive	Minor	None
2.	Moderate	$<10^6$-10^7	1.0-1.5	Mod Explosive	Moderate	None
3.	Mod-Large	$<10^7$-10^8	3.0-15	Explosive	Sustained	Posible
4.	Large	$<10^8$-10^9	10-25	Large Explosive	Sustained	Definite
5.	Very Large	$<10^9$-10^{10}	>25	Severe	Sustained	Significent
6.	6	$<10^{10}$-10^{11}	>25	Violet	Sustained	None
7.	7	$<10^{11}$-10^{12}	>25	Terrific	Sustained	None
8.	8	$>10^{12}$	> 25	Cataclastic	Sustained	None

A = Description;
B = Volume of ejector(m);
C = Column height (for EVI O-2 : km above crater);
D = Type of eruption ;
E = Tropospheric injection (<15 km altitude all weather);
F = Stratospheric injection(>15 km, <50 km altitude, No clouds). (source : Newhall & Self, 1982; A.L. Bloom, 1992, Modified.)

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R.S.J. Sparks and S.N. Carey developed a method in determining volcanic intensity of past explosive eruptions from the grain size features of fallout deposits. The 1980 Mount. St.Helens eruption provided a convenient test for the reliability of intensity and column height determination from a fallout deposit (Fig. 5.2) The study of H.Sigurdsson on the 50 fallout deposits from explosive eruptions indicated a strong positive relationship between eruption column height, volcanic activity (log of discharge rate) and magnitude total erupted mass (Fig. 5.3).

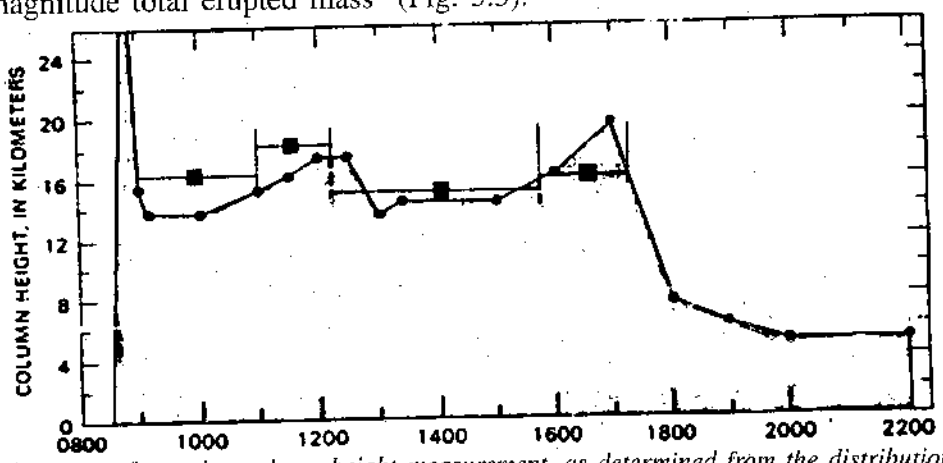

Fig. 5.2. A test of eruption-column-height measurement, as determined from the distribution of lithic fragments from a pyroclastic fallout. The diagram shows the column height (radar observations) during th ePlinian stage of the May 18, 1980, Mount St. Helens eruption, determined by radar fron 800 hours to 2200 hours (shaded), and the column height derived from measurement of the diameter of lithic fragments in four units of the fallout deposit near the vent (solid squares). The agreement between observed and calculated column height is generally within 2 km.

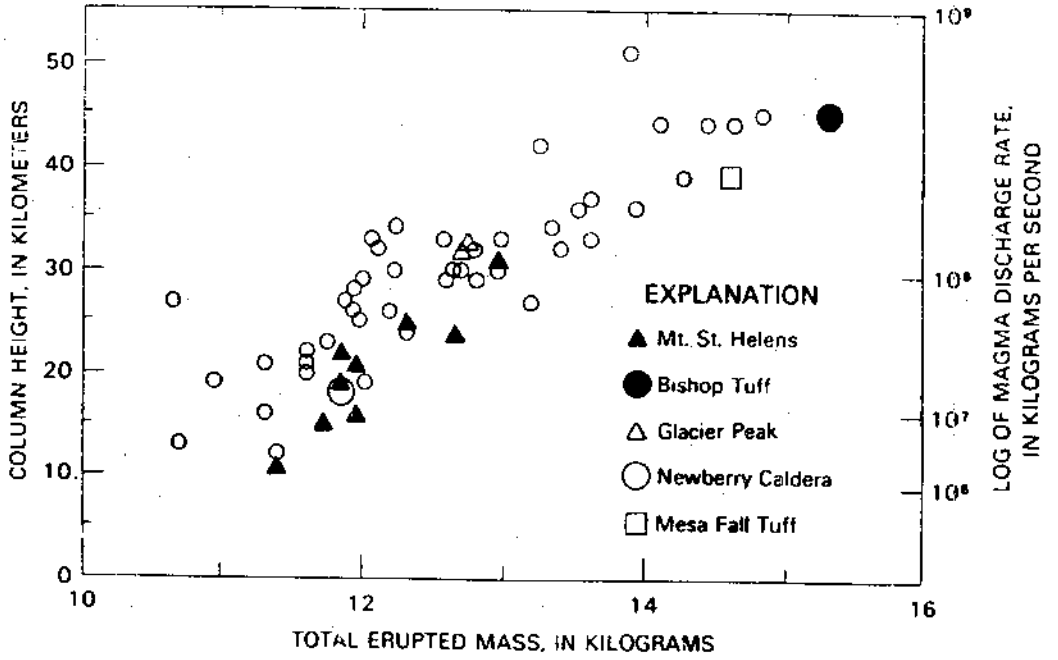

Fig. 5.3. The relationship between eruption-column height, volcanic intensity (log of discharge rate) and magnitude (total erupted mass) for about 50 explosive eruptions. The solid triangles show the nine Mount St. Helens eruptions of the past 4,000 years. Other symbols are for the peak intensity of the Plinian phase of several major explosive eruptions in the western United States.

5.6. CLASSIFICATION

Volcanoes are also classified based on shape of the vent and material make up of the volcano as given below

1. Central Vent Type

This type of volcano has a central vent - a cylindrical conduit for extrusion of magma.

Strato -volcanoes or composite volcano : These are made up of repetitive layers of lavas and pyroclastics. They are conical in shape, with steep flanks (slope : upto 40) and surmounted by a crater. Generally associated with intermediate and acid lavas ; mixed explosive and eruptions . e.g. Tonga Island, New Hebridges(Supra subduction zone);Mayon volcano, philippine Islands; Cotopaxi volcano (Altitude : 5947 M) Ecuador.

Shield Volcanoes : These are mostly made up of lava flows with gentle flanks(slope: $< 10^0$) Mostly associated with effusive eruptions and basaltic lavas. e.g. Basaltic shield volcano, central Iceland, Mauna Mea (Altitude : 4206 m) Mauna Loa, Hawali islands.

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2. Fissure Type

The magma, generally basaltic in composition, wells out through a fissure formed in the lithosphere under tension. The fissure may run hundreds of sometimes thousands of metres. e.g. Mid-oceanic ridge volcanic activity : 1975 - 1985 Kratla volcano, Iceland ; 1783 Laki eruption (south east Iceland) Fissure lengths : 25 km; Total covered area : 500 km; Continental regions under tensional stress ; Deccan baslats; East Greenland basalts; Columbia basalts. N.W. of US.A.

3. Table Classification of Volcanoes

This classification was based on plate tectonic model.

Basalt (SiO_2, 48%) ; 1. Generally 1200°C . Flow till about 700°C 2. Normal basalt > 5,000 poises, 3. Effusive. 4. Hot Spot : Hawaili volcanic Islands : Mid- oceanic ridge : Iceland Volcanoes

Andesite (SiO_2 57% ; Na+K, 4-6%) Lava Type 1. 1200°C 2. More viscous than basalts. Ceases to flow below 980°C 3. Explosive. 4.Supra-subduction zone volcanoes of Andean Cordillera, South America.

Rhyolite ($SiO_2$72% ; NA + K . 7-10%) Lava Type 1. 1200°C 2. More viscous than andesites. 3. Explosive. 4. Rift valley : East African Rift valleys - Mixed flows

Trachyte (SiO^2 59% ; Na+K 10-12%)Phonolite(SiO_2 54.5% NA+K. 12-14%) (Alkali/ SiO_2 High) Lava Type 1. 1200°C 2. Low viscosity and highly mobile, especially when enriched with Cl, F. 3. Effusive.

Large Oceanic Lave Type Intraplate, Rift related continental volcanoes. Greenland, Kenya.

Carbonates Lave Type (Na & K Carbonates with Cl & F) 1. 900°-1200°C 2. Flow like water till it reaches around 500°C 3. Effusive 4. Rift valley of Northern Tanzania, Oldoinyo Lengai Volcano.

1. Temperature 2. Viscosity of lava 3. Type of eruption 4. Location and example.

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5.7. OCCURENCE AND DESTRIBUTION

There is a close relation between volcanoes and the plate boundaries(Fig - 5.4) The present active volcanoes are about 500 but those that the dormant or recently extint may amount to several thousands.

1. World Distributions

Majority of the present active volcanoes are resituated in or near the circum - pacific and the Alpine-Himalayan belts. Another note warthy places for volcanoes are the African rift valleys and their continuation north of the Red sea. Other scattered groups of volcanoes occur in the pacific, the Atlantic and the Indian Oceans. The Circum-pacific track, which has been called "the ring of fire " extends northwards along the Andes through central America into Mexico, through United States and Canada into Alaska, then along the Aleutian islands to Asia and turning southward through Kamachalka, Japan and the Philippines it crosses the East Indies and by

various island chains again passes into pacific. Another belt extends westward from Baluchistan through Iran to Asia minor the Mediterrannean, the cannary and the Azore islands, trending towards the west Indies. Another important highly active belt of volcanoes occur in the for eastern continuation of Alpine Himalayan orgenic belt, which extends through Sumitra, Java, New Guinea and the Philippine islands. A thirld belt extends from palastine southward through Arabia, the red sea, Ethopia and East Africa to Medagasar

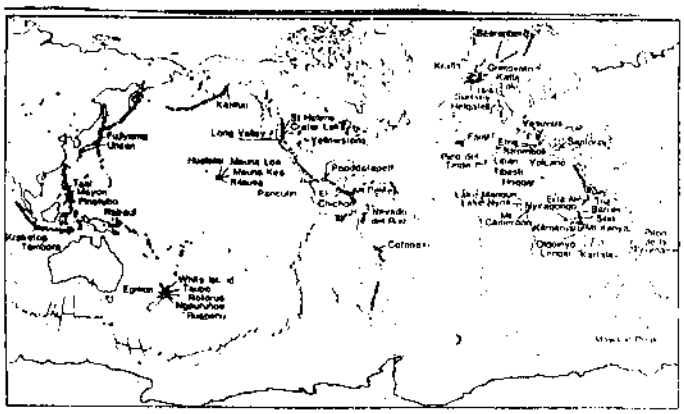

Fig. 5.4. Map of the active volcanoes of the world. Tectonic plate boundaries are also indicated.

A great mojority of Volcanoes now active or recently extinct lies in belts subject to frequent earthquakes. This belts also inculde the great mountain systems that formed late in the geological history.

2. Distribution in India

The only volcano of India is a Barren Island in the Andaman sea. The Barren Island is near circular in shape and stand 354 m above MSL. The volcano has a symmetrical cone and surmounted by a crater (Dia : 1.3 km) V.K. Raina(1983), J.Bhattacharya(1988) confirms the F.R.Mallet(1885) findings that the younger cinder cone has formed in the older explosive crater. The volcano erupted in May, 1991, after nearly 200 years (1795 and 1803 eruptions). The lavas are basalts and basltic andesites. The Narcondam and Barren Islands are part of Burma - Sumitra - Java inner volcanic arc - trench system. In this region Indian Ocean crust (part of India plate) subducts Eurasia plate.

3. Mud Volcanoes

An accumulation usually conical of mud and rock ejected by volcanic gases. These small forms (Ht. 45 to 95 m) associated with exhalative vents are reported from Copper River Basin, Alaska, which discharge mineralized warm water and gas(Bloom, 1992). D.E. white(1955) reported a mud volcanic ereption in 1951 at Lake city Hotsprings, north eastern California. It happened suddenly with eruption of steam, gas and mud to a height of 1000 m . The mud air falls fallen on farms and a town, 7 km downwind from the eruption. The energy for this eruption is presumed to be volcanic heat with water mostly from near surface sources. The non - volcanic mud volcanoes, related to eruptive hydrocarbon gases are observed in Arakon Yoma area of Burma, Makran coast of Pakistan and Mississippi delta of U.S.A. The Western group of Arakan Yoma are in the coast as well as in the islands - Ramri, Cheduba and other islands.

BRAOU

Check Your Progress 3 & 4

3. Name the two important belts of Volcanic activity.

4. Where lies the volcanoes in India ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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5.8. ENVIRONMENTAL IMPACTS

Volcanic eruptions cause low annual losses when compared with earthquakes and floods. The volcanic products affect environment around the active volcano. Volcanic hazards are due to lava flows, lahars, ash and gases. Other are ; earthquakes, floods, landslides and tsunami.

5.8.1. Lava flows

Defination

" A lateral, surficial outpouring of molten lava from a vent or fissure. Lava field is a more or less well - defined area that is covered by lava flows.

Characteristics

The area of lava field depends upon the type of eruption, quantity and chemical composition of lava, and topography. In the effusive type of eruption, basaltic lavas which are highly mobile generally in good quantity over tens of square kilometers, when compared with the explosive eruption associated with acidic lavas. The presently available data, collected by the volcanologists, it is possible to predict volcanic eruption and type of lava.

Effects

As the temperature of lava is around 1200°C they burn and burry the natural and anthropometric features. As the velocity of flow is very small, the risk for the people is low but for property, hig. The secondary effects floods and mud flows are observed with volcanic eruptions on snow/ice fields.

Mitigation

The chemical composition, etc. are known for active volcanoes, consequently necessary precautions can be taken in land use zoning. The modern volcanic eruption monitoring equipment in the active areas will give ample notice to clear the people in the possible lava flow directions. The lave flows can be bombed and also cooled by water to dissipate the flow energy.

BRAOU

5.8.2. Lahars

Definition

Lahar is "a mud flow composed chiefly of volcanic clastic materials on the flanks of a volcano. The debris carried in the flow includes pyroclasts, blocks from primary lava flows and epiclastic material". Hot Lahar is a flow of hot volcanic materials down the slope of a volcano, produced by heavy rains after an emption or by intrusion of lava into ice, snow, or water saturated soil.

Characteristics

They are generally associated with pyroclastic materials which are produced in large quantities by explosive or mixed emptions. They occur suddenly and move with velocities of tens of miles per hour. The destruction is controlled by topography beyond volcanic flanks. They cover generally a few square kilometres and rarely a few hundreds of square kilometres and follow the valley floors. The frequency may be one to several per century caused by direct eruptions. They are predictable as they are related to central - vent volcanoes and restricted by volcanic flanks and valleys leading from them e.g. 1982 - 1983 Galunggund Volcano, Western Java. Total pyroclastics : 300 million c.m. In 1882 eruption it produced 22 km long mud flow.

Effects

Land and civilization suffer burning, burial, dislodgment, impact damage and inundation by water. The risk is moderate to high for both people and property near eruption volcano. But more people will suffer as hot lahars are sudden and speedy. The risks decreases down valley and also, in heights above the valley floor. E.g. 1985 November 13 Nevada del Ruiz, Colombia, Glacier topped. Destroyed villages and towns. Loss of lives : 25,000.

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Mitigation

It is not possible to mitigate lahars. The general evacuation of people from the volcanic eruption area based on predictions will reduce human toll but loss of property is inevitable.

5.8.3. Volcanic Ash

Definition

Volcanic ash is a fine unconsolidated pyroclastic material (under 2.00 mm diameter; fin ash ; under 0.063 mm diameter). Ash flow is " a density current, generally a high heated mixture of volcanic gasses and ash, travelling down the flanks of a volcano or along the surface of the ground; produced by the explosive disintegration of viscous lava in a volcanic crater, or by explosive emission of gas- charged ash from a fissure or group of fissures"

Alfred Lacroix named this phenomena as "nuee ardente" (glowing cloud) after observing it in May 1902 mount. pelee eruption(Martinique Island) It killed 30,000 people in St.Pierre. e.g. 1930 Merapi volcano, Central Java, Semeru volcano, Eastern Java.

Characteristics

The volcanic ash covers thousands of square kilometres which depends on type of lava and eruption, quantity and height of eruption , and wind velocities. The solid materials contained in a typical ash flow are generally unsorted and ordinarily include volcanic dust. pumice, scoria, and blocks in addition to ash. They are produced suddenly and move away from the vents at speeds of tens of miles per hour. Based on the type of vent, lava type, wind direction. etc. , they are moderately predictable. The frequency may be one to a few eruptions of small volume in a century.

Effects

Near to the volcanic vent, the land and manmade structures suffer blast effects, burial and infiltration by abrasive rock particles and associated corrosive gases. The effect of blankering by ash and dust and infiltration by fine ash can reach hundreds of miles in the wind direction, depending on type and size of eruption. The ash cloud will effect air flights. The frequency may be one to a few eruptions of small volume per hundred years. The risk is moderate to people and property near erupting volcano and decreases to a very low rate downwind.

Mitigation

It is possible to mitigate the volcanic ash hazard by bombing the volcanic vent just before the eruption.

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5.8.4. Volcanic gases

Definition

Volatile matter, released during a volcanic eruption, that was previously dissolved in the magma.

Characteristics

" Water vapor forms about 90% of the gases, other constituents include carbon gases especially CO_2 sulphur gases, especially SO_2 at high temperatures and hydrogen sulphide at low temperatures ; hydrogen chloride ; nitrogen as a free element". Also less volatile components sublimate in and around the volcanic vents. In African rift volcanoes CO_2 is the dominant one. e.g. volcanic gases. Kilauea, Hawai, 80% H_2O subordinates : SO_2, CO_2, H,<1%. : CO, H_2S, HF ; Trace ; Hg,Cu & other minerals. The estimated annual global volcanic SO_2 flux is 18.7 million tones (e.g. 1980 Pinatube volcano. Philippines. SO_2 : 3.3 million tones ; 1982 El Chichon Volcano, Mexico.$SO_2$8.25 million tones.

Effects

The volcanic gases give rise to order " haze" and acid effects . They destroy life by asphyxiation and also infiltrate and corrode the structures and equipment. e.g.. 1. 1783 Laki fissure eruption. Island. The tranquil exsolution of gases from the lave caused blue haze or "dry fog" over Iceland and parts of northern Europe. Consequently 11,000 cattle; 28,000 houses ; 190,000 sheep died and resulted in a severe famine in which about 10,000(20%) population of Iceland died. 2. August 15, 1984. Lake Menoun Cameroon Volcanic chain, CO_2 gas eruption. Killed 37 local people. 3. August 26.

1986. Lake Nyos Cameroon volcanic chain . CO_2 gas eruption. 1.94 x 10^6 tones (approx.) Affected region : 63 km^2 83000 livestock and 1746 people died.

In moderate to large explosive eruptions, the gases with volcanic ash are pushed into the stratosphere - height > 15 km(e.g. 1883 Karkatau, Indonesia; 1980 Mount St. Helens. U.S.A; 1956 Bezmianny Kamchatka Peninsula). The sulpohur gases and other susceptible to oxidation and hydration in stratosphere produce long life volcanic aerosols. The aerosols with volcanic ash block solar radiation resulting in climatic changes.

Mitigation

It is possible in future to mitigate the volcanic gas effects by drilling for the extraction of gases. which reduce pressure in the magma chamber in the volcanic areas.

5.8.5. Volcanic Earthquakes

Definition

An earthquake associated with volcanic rather than tectonic forces.

Characteristics

There are three types of volcanic earthquakes associated with volcanic activity. The volcanic explosions produce numerous small sharp shocks that can be recorded by seismographs and correlated with actual explosion. The shallow shocks generally increase in number before eruption and recorded by seismographs of low magnification. The volcanic tremor is either due to successive small shock of the first two types or volcanic processes that setup and maintain a natural oscillation of the volcanic area. The tectonic shocks are associated with volcanic eruption. Some of the earthquakes with focus between 60 and 100 km depth, here magma is generated, are directly related to volcanic activity in plate margins (e.g. Circum - Pacific belt) and mid - oceanic ridges, where they occur together. In hot spot related volcanoes (e.g. Hawaili) earthquakes accompany volcanic activity. The other causes for volcanic earthquakes are : increasing topographic load, rapid underground temperature changes, moving magma, and gas explosions. In a study of 71 earthquake swarms and volcanic erutpions, 58 per cent showed an increase in earthquake activity before eruptions, 38 percent are increase without eruptions and 4 per cent eruption without increase in seismicity.

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Effects

The volcanic earthquakes destroy man made constructions in an area around the volcano. But the modern volcanology uses the seismic studies in and around the volcano, for prediction purposes. For example the data collected at Asama Volcano Observatory, Japan showed that number of earthquakes and their localities are useful in forecasting eruption.

Mitigation

Landuse zoning is the only solution for mitigation the volcanic earthquake hazard. The prediction techniques save the people but the property is at the mercy of hazard.

Others : The other volcanic hazards are tsunami(e.g. 1883 Krakatau killed 36,000 people on the shors of Java & Sumatra Island) ; change in the profiles of land and rivers (e.g. 1912 Katmai volcano, Alaska, Burried Kodiak Island) contamination of waters. The covered areas by lavas and pyroclastic take time to bring them under plough and settlements.

5.8.6. Sub- marine Volcanic Activity

Definition

The eruption of volcanic products from vents or fissures on the sea floor into the ocean waters

characteristics

The submarine volcanic activity is mostly associated with mid-oceanic ridges and also observed in intra-oceanic plate region. The magmas reach the mid - ocanic ridges because of availability of faults at the divergent plate boundary; buoyancy of magma (Baslat. Dencity : 2.65 g/cm at 1200^{0}C) viscosity of magma (Basalt 1-2 k bar. pressure. 10 g/cm^2.) and high thermal gradient. The lava is chilled by the ocean bottom cold water and from pillow lavas are formed. The emanations(white smokes . 300^{0}C; Black smokes 350^{0}C) disseminate in the water and most of it precipitate around the chimney.

Effects

The variety of life recorded by submercibles at these depths near the chimneys indicate their adaptability. The observed fauna comprise of giant tube worms. crabs, clams, etc. The precipitate of emanations gives rise to mineral deposits (e.g. Red Sea)

Mitigation

It is not possible to mitigate this colossal phenomenon on the ocean bottom.

BRAOU

Check Your Progress 5 & 6

5. What is the difference between lava flow and lahara.

6. What is the metigation process to volcanic gases.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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5.9. VOLCANIC RESOURCES

The most important volcanic resource which is being harnessed is geothermal energy associated with volcanic activity on land. The volcanic gases(80-90% steam) from

depths are exploited by drilling and processes for steam to run the turbines that produce electricity. The three types of geothermal prospects related to volcanic activity are : hydrothermal reservoirs, hot dry rocks and magma reservoirs. Of these three hydrothermal reservoirs are the easiest to exploit and develop e.g. Larderello, Italy(From 1904); Iceland(from 1925) The Geysers,California(from 1959) Newzeland, Kenya.

According to U.S. Geological Survey, the potential geothermal energy resources (up to 10 km depth) in U.S.A are : hydrothermal reservoirs12 x 10^{21} joules); hot dry rock 32 x 10^{24} joules); magma reservoirs (40 x 10^{23} joules). That is, the total geothermal energy of U.S.A is about 6000 time of the energy available in the world oil reserves. The technology to exploit the second and third type of resources is being developed. In India, hydrothermal type is available in the Puga valley(Ladakh) Andaman and Nicobar 'Islands. The hot water springs are developed into health resorts in many countries.

A lightfall of volcanic ash and dust increase the productivity of the soil because of the moisture-conserving effects of the ash, which act as a mulch particularly, in the semiarid climate.

Volcanoes though hazardous are aesthetic resources for recreation and tourism, e.g. Hawaili volcanoes National Park; Mt. Kilomanjaro, Africa, : Mt Rainier ; U.S.A ' Mt. Fuji, Japan.

5.10. PREDICTION OF VOLCANIC ERUPTION

In volcanology, prediction of volcanic eruption - time, place, character - is an important study. The active volcanoes are continuously manned by scientists with modern equipment i.e., seismographs, geodetic surveys, tiltmeters, remote sensing, gas analyses, etc

Volcanic tremor consists of more or less continuous ground vibration with a frequency of 0.5 to 10 cycles per second - detectable by seismographs. There is a generaly increase of earthquake swarms with volcanic activity. So, the number., size and location of earthquakes on active and dormant volcanoes will help to predict the volcanic eruption. Every volcano have its own seismic characters which need detailed data collection and analysis using fast computer techniques. For example, high amplitude volcanic tremor is generally the best indicator for an eruption that has began or will begin. The tiltmeters (1 part per million - Microradian) and geodimeter(m) measurements of changes in the slope of distance between survey points on the summit and flanks of volcanoes are very useful in prediction. e.g. The Kilauea volcano (Hawaili) will erupt if the tilt is 1400 microradians and no eruption will occur if it is below 1100 microradians. The Mouna Loa (Hawaili) a dormant volcano for 25 years was predicated to erupt before summer 1978, from observed increase in seismicity and caldera size 75-mm (actual : 3 km) but it happened on 1975 July 5th & 6th(30 million cubic meters of lava). Another good example for prediction is mount St. Helens Cascade Range, Washington. U.S.A.

The study of changes in the Earths magnetic and electrical fields and also gravity in and around the volcano are useful tools for prediction. E.g. 1966 Kamchatka. U.S.S.R.

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The temperature studies of crater lake, steam vents , hot spring, melting of ice and snow irrespective other natural causes for a volcano will help prediction. e.g. the 12^0 C rise of the crater lake at Taal (Philippines) signaled 1965 eruption.

The chemistry of volcanic gases and their abundance is important in the prediction for example, increase in SO_2 /Cl ratio at volcanic steam vents before volcanic eruption is observed in Japan, and U.S.A.

The remote sensing data, the time sequential study in different enerygy bands, is another modern tool for volcanic eruption prediction.

The multidata analysis for each volcanic zone and volcano will make the forecasting technique into a predictable one which will help to reduce the loses of human resources.

Check Your Progress 7 & 8

7. How volcanic products effects the soil.

8. Name the equipment useful to study volcanoes.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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5.11. SUMMARY

Natural hazards are those occurrences brought about by the forces of nature that cause discomfort, injury or death to life, damage or destroy the physical structures and property. Volcano is a one such hazard. Volcano is a vent or fissure in the surface of earth through which magma and associated gases and ash comes out. Lava is a molten form of magma. Magma is a naturally occurring mobile rock material generated within the earth. The volcanic products are classified as gaseous (fumes like H_2O, SO_2, CO_2, HCl, H_2S, He etc) Solids (dust, ash, cinder, flocks, bombs etc) Liquids (Lava).

Volcanoes are classified based on shape of the vent and material makeup into 1) Central vent type and 2) fissure type. There is a close relation between volcanoes and plate boundaries. Majority of present volcanos are situated in and around circum - Pacific and Alpine-Himalayan belts. In India the only important volcano lies in the Barren island of Andaman sea.

The volcanic products affect environment around the active volcano. Volcanic hazards are due to lava flows, ash, gases, etc. Volcanic eruption also causes earth quakes,

floods, landslides etc. Lava flows can be avoided by landuse planning and also this will be detected by scientific equipment in the active areas, enables to clear the people in the possible lava flows direction. Lahar is a mud flow of volcanic products and evacuation based on prediction will reduce human loss but property loss is must. Volcanic ash is fine volcanic particles. Bombing the volcanic vent before eruption controls volcanic ash hazard. Volcanic gases like SO_2, CO_2, H_2O, H_2S etc can be controlled by drilling out this gases from volcanoes. It is not possible to control submarine earthquakes, floods, landslides etc.

The volcanic resources are the geothemal energy and drilled gases. The soil formed with volcanic ash and dust consists more productivity nature. Prediction of volcanic eruption is possible by continuous study with the help of modern equipment-like seismographs, geodetic surveys, tiltmeters, remote sensing, gas analysis etc.

5.12. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Volcano is a vent or fissure in the surface of the earth through which magma and associated gases and ash erupt.
2. Volcanic fumes, tephra, volcanic dust, volcanic ash, volcanic cinder, volcanic blocks, volcanic bombs, lava, water etc. are the volcanic products.
3. Circum -Pacfic belt and the Alpine-Himalayan belt are the two belts of volcanic activity.
4. The volcano in India is Barren Island in the Andaman sea.
5. Lava flows are the lateral, surfacial out pouring of molten lava from a vent or fissure where as lahar is a mud flow composed chiefly of volcanic clastic materials.
6. The mitigation process to volcanic gases is by drilling and extraction of gases.
7. Volcanic ash or dust increases the productivety of the soil because of the moisture-conserving effect of ash.
8. Seismographs, geodetic surveys, tilt meters, remote sensing techniques, gas analys. etc are useful to study volcanoes.

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5.13. MODEL EXAMINATION QUESTIONS

I Answer the following questions in 30 lines each.

1. Write an essay on the origin and classification of volcanoes
2. Write down the environmental impact of volcanic products.
3. What are volcanic resources

II. Answer the following questions in 10 lines each.

1) What are volcanic products
2) Write the distribution of volcanoes on globe
3) How volcanoes can be predicted

Prof V.R.R.M. Babu

UNIT-6: EARTHQUAKES

Contents

6.1. Objectives
6.2. Introduction
6.3. Origin
6.4. Earthquake waves
6.5. Terminology
6.6. Seismographs
6.7. Classification.
6.8. Distribution
6.9. Environmental Impacts
6.10. Reservoir Induced Seismicity
6.11. Earthquake Prediction
6.12. Summary
6.13. Check Your Progress : Model Answers
6.14. Model Examination Questions

6.1. OBJECTIVES

After completion of this unit, you should be able to :

* define earthquakes and origin of earthquakes,
* explain the earth quake waves and terminology associated with earthquakes,
* describe the classification and distribution,
* explain the environmental problems such as ground shaking, surface faulting landslides, Tsunami etc. and their mitigation process,
* describe the prediction techniques for earthquakes.

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6.2. INTRODUCTION

Earthquakes are natural hazards like volcanoes, floods, cyclones, etc. The Plate Tectonic Theory of Morgan(1968) explains the origin of continents, oceans, volcanoes as well as earthquakes. An earthquake is a vibration or oscillation of the surface of the Earth for a few seconds caused by a transient disturbance of the elastic or gravitational equilibrium of the rocks at or beneath the surface. Seismology is the science of earthquakes and related pehnomena (Greek, Seio, to shake ; Seisomos, an earthquake).

6.3. ORIGIN

The release of stress in the rock mass by natural process or due to man made structures result in an earthquake. The slow and steady movement of the plates is the fundamental natural cause of earthquakes as it causes accumulation of stress in rockmass. The increase in the stress will build up elastic strain in the rockmass. As the rockmass has variable mechanical properties, it suffers dilatancy and inturn fractures develop. The groundwater, as well as, water released from the hydrous minerals will occupy the cracks. As a result, the mechanical properties of the rock are reduced and stress is

released suddenly causing break, and the rock rebound along the fault plane. The displacement and rapture due to the break, spread along the fault surface at a rate of 2-3 km/sec. The seismic waves , with energy levels proportional to the released quantity of stress, travel in different directions. According to Hugo Benioff, the large or small seismicity indicates release of regional stress which accumulates in the principal faults and active structures or minor tectonic features respectively, in the region. The other natural phenomena that cause earthquakes are landslides, avalanches, collapse of caverns, volcanic eruptions and movement of magma, and transformation of material at depth.

Earthquakes are also produced by human activity-explosions, dams reservoirs, mining etc. In explosions (nuclear) the shock is a transient pressure pulse whereas, for dams static pressure is the crucial factor. The mining activity causes disturbances in the natural stress field in surrounding rock masses. The release may take place at points, where the stresses exceed the strength of the rock material resulting in a rock burst in the mine and an earthquake effect on the surface(e.g. Kolar Gold Fields)

6.4 EARTHQUAKE WAVES

In the earth, the Earthquake also called as seismic waves travel with different velocities in heterogeneous rock formations and also, suffer reflection and refraction at their boundaries. Seismic waves are recorded by a seismograph. The two main types seismic waves (fig 6.1) are body waves and surface waves

Body Waves : propagate in every direction through the interior of the earth and they are a) longitudinal waves or P(Primary) waves ' b) transverse(or shear) or S (Secondary waves (Table 6.1. Fig 6.1)

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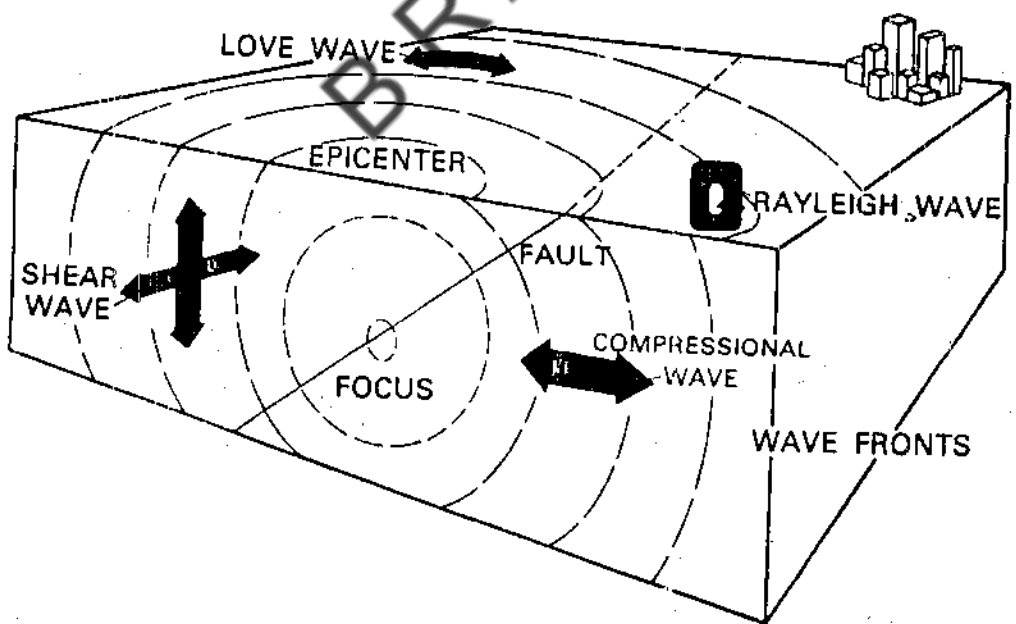

Fig. 6.1. Schematic illustration of the derections of vibration caused by body and surface seismic waves generated during an earthquake.

The P waves are compression -dilation(or compression rarefaction) waves and the particles vibrate parallel to the direction of propagation. P-Waves are similar to sound waves, they pass through gases, liquids and solids. The S waves or shear waves travel

only through solids, with a lesser velocity than of P-Waves and the particles vibrate at right angles to the direction of propagation, similar to the light waves. The velocity of the P - Waves is 1.7 times that of S waves in the upper parts of the earth. The P and S waves disperse their energies in the ratio of $1/d^2$ (d distance from the source of the earthquake, Table 6.1).

Table 6.1. Velocity of P and S waves in different rocks in different regions of India

(source : A.N.Tandon, 1992)

	1		2		3		4		5	6	
	P	S	P	S	P	S	P	S	P	P	S
A	-	-	-	-	-	-	-	-	2.70	-	-
B	5.26	3.29	5.58	3.43	-	-	5.67	-	6.20	5.67	3.46
C	6.21	3.71	6.55	3.85	-	-	6.44	-	6.90	6.51	3.96
D	7.80	4.38	7.91	4.46	8.00	4.54	8.25	4.75	8.20	7.98	4.61

P - P-Wave Velocity(km/sec.); S-S-Wave velocity(km/sec.)

1. Gangetic Valley 2. Northeast India 3. Indian Region

4. Deccan Shelf 5. Indian Region 6. Near Gauribidanur Array

A. Sedimentary B.Granite C.Basaltic D.Base of Moho

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Surface Waves

Surface waves or guided waves, which propagate along some surface and consist of the following types : a) Love(L) and Rayleigh(R) waves which follow the free surface of the Earth.

b) Stoneley waves, which are related to Rayleigh Waves, but follow a discontinuity surface in the Earth's interior.

c) Channel waves, which propagate along some layer of lower velocity in the Earth's interior.

Surface waves are associated with boundaries between materials of different velocities and densities. These waves spread out and disperse their energy over a surface nearly according to the ratio 1/d . Their velocity is between 4 and 5 km per second and cause destruction. Among the surface waves, Rayleigh and love waves are the most frequently observed on the seismogram. Whereas, Stoneley waves are generally absent as they are restricted to internal discontinuity surfaces in the earth and the layers adjacent to such surfaces.

In Raleight waves, the motion of the particles is in elliptical orbits in the vertical plane of propagation. In Love waves, the motion of the particle is horizontal and right angles to the direction of propagation, which are like horizontally polarized S waves.

As most of the earthquakes have their focus in the crust, they give rise to surface waves of largest amplitudes, far exceeding the amplitude of body waves. Body and

surface waves cuase the ground movement and consequently, a building will vibrate in complex manner.

Check Your Progress 1 & 2

1. What is a an Earthquake ?

2. What are the differences between P Waves and S waves ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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6.5. TERMINOLOGY

The earthquakes have the kinematic parameters - focus, epicenter, origin time-which are calculated from the arrival times of the seismic waves at various seismological stations. The dynamic parameters - size of the event is calculated from amplitudes and periods.

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Focus (Hypocentre)

It is the place of origin of disturbance that caused an earthquake. The point above the focus and on the earth's surface is called EPICENTRE and the area of the maximum damage around it depends on the earthquake magnitude.

Size of the Event

Earthquake - is expressed as intensity/magnitude/energy/of seismic movement. These parameters are developed with the developments in seismographs and seismology.

Intensity

Based on the observations of 1755 Lisbon earthquake, Mitchell recognised that the destructiveness of earthquake and intesity, decrease outwards from the source. Before the advent of seismograph this is the only way to locate epicentre of the earthquake and also, to draw isoseismals based on macroseismic observations. A line drawn through all the places with the same intensity is an isoseismal line (Fig 6.2). The intensity has been expressed based on the characteristic effects into the orbitrary scale of I to XII, as given by Mitchell, modified by Mercalli and other based on the observations and standard questionnaires in the earth Quake belt area.

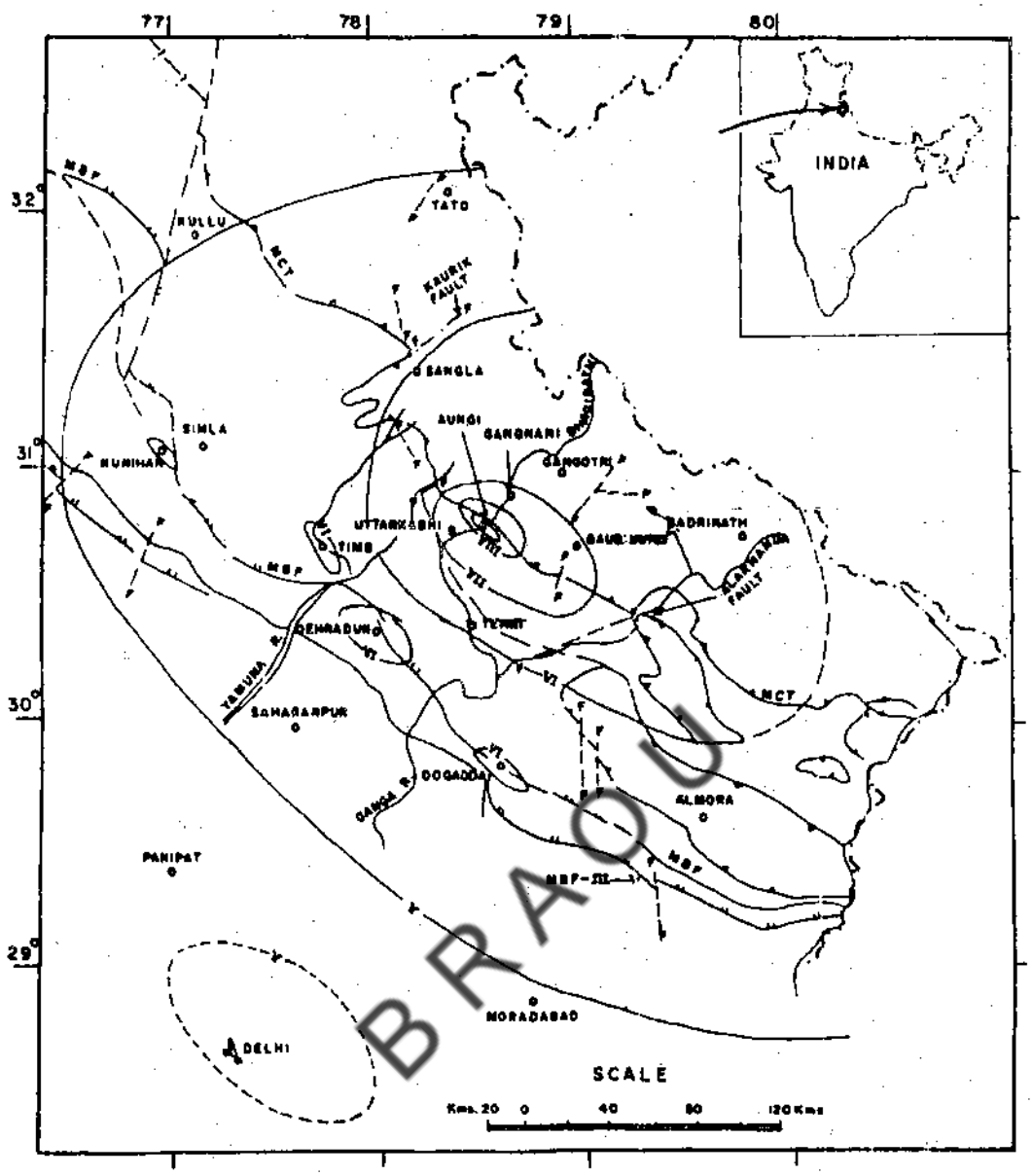

Fig. 6.2. Isoseismal Map of Uttarkashi Earthquake.

The general formula for intensity is

$I_0 = I_S + 3 \log [(d^2 + h^2)\ h^2]$

However, the intensityincrease in unconsolidated ground and decreases in firm rock.

Magnitude

C.F.Richter(1935) after the study of earthquakes of California, defined magnitude (M_L) as the logarithm of the maximum recorded (trace) amplitude(expressed in microns) by a wood-Andersen torsion seismograph with specified constants(Free Period - 0.8 sec.; Maximum magnification - 2800; Damping factor - 0.8) when the seismograph was at an epicentral distance of 100 kms. B.Gutenberg (1945) developed magnitude scale(M) based on surface waves, applicable to any epicentral distance and to any type of seismogrph. Gutenberg and Richter (1956) determined unified magnitude(m), based on the body waves. Finally, the International Geophysical Assembly1967, (Zurich) took an important step towards greater unification of the magnitude.

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Energy

In an elastic wave of given period is proportional to the square of the amplitude. Magnitude is related to the energy of the elastic waves radiated from the earthquake source.

The magnitude of the earthquake is same at all seismological stations whereas, intensity get reduced from the epicentre outwards. The main significance of magnitude is in the scientific classification based on energy released against arbitrary MM scale classification. The magnitude scale of Richter does not lie between 0 and 10, however, for large earthquakes it is an approximation.

Sesmic Movement

Sesmic movement is another dynamic parameter like magnitude. It is defined by the following equation.

$$M_0 = \mu DS$$

where

M_0 = seismic movement
μ = modulus of rigidity
D = average dislocation on a fault plane
S = area of a fault plane

The average annual release of energy from all earthquakes ranges from 10^{18} to 10^{20} Joules and 80 percent or more is from a few major earthquakes. Over 75% of the energy is released in shallow focus event and only about 3% in deep focus earthquakes. Only one percent of the earthquakes's energy is propagated away in seismic waves. The rest is converted into potential energy which can be seen as uplift of large areas of ground and crushed materials in the fault zone and also kinetic energy, heat (e.g.1819 Cutch earthquake, Allah bund).

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6.6. SEISMOGRAPHS

Chang Heng (Chinese astronomer) in 132 A.D devised Seismoscope to record earthquake(Fig. 6.3).

Fig. 6.3.The first recorded 'seismoscope', devised in AD 132 by the Chinese astronomer Chang Heng. A pillar, suspended in the dome-covered cylinder, swayed in the direction of the initial motion when the instrument was disturbed by an earthquake, and operated a mechanism which knocked a ball from the nearest dragon's head into the mouth of the frog beneath. (The Science Museum, London)

In 1880, Gray,'Milne and Ewing developed first effective seismographs. The modern seismographs were developed between first and second world wars(Fig 6.4.) The fundamental characteristics of seismographs area (a) heavy masses supported by springs; (b) long pendulums suspended from high structures ; (c) horizontal pendulum to measure horizontal movement(Milne-Shaw horizontal seismograph) In seismometer, the electromagnetic principle of converging the motion into a recorded signal is used. The recently developed broad band seismometer can detect a whole range of frequencies of seismic waves, including the very long wave lengths, by means of electric feedback mechanism.

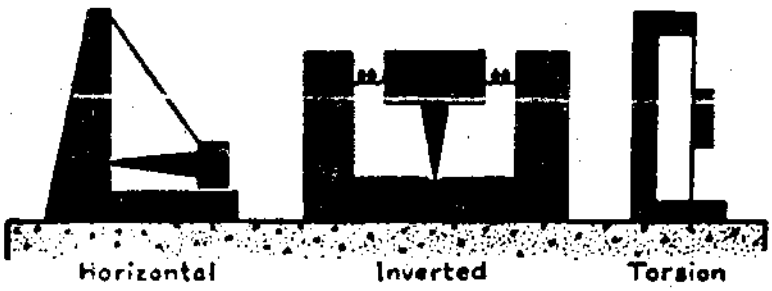

Fig. 6.4. Diagrams illustrating the principle of seismographs using the horizontal bracket pendulum (Milne), the inverted pendulum (Wiechert), and the small torsion pendulum (Anderson Wood, Nikiforov).

In 1960s,World wide standard seismogrph network (WWSSN) established more than 100 seismic stations, each having six seismographs to detect vertical, N-S, E-W ground motions at 1 second and 20 seconds period. The Bhabha Atomic Research Centre, in 1968, established a seismic array at Gauribidanur near Bangalore essentially to distinguish between the records of under ground nuclear explosions and natural earthquakes. Three strong motion Arrays were established in Kangra area, Himalayan region of U.P. in 1980 and 1990s, to get useful information for earthquake disaster mitigations by Department of Science and Technology, Government of India.

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Check Your Progress 3& 4

3. Who and when first seismoscope developed?

4. Identify the difference between focus and epicentre?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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6.7. CLASSIFICATION

The earthquakes are classified as tectonic, nontectonic and man made, based on the origin.

Tectonic Earthquakes

These are due to disturbance in the geological formation that are taking place in the Earth's interior. Gutenberg and Richter classified them based on the depth of focus as shallow (less than 70 km), intermediate(70 to 300 km) and deep (300 km and above). No earthquakes have been recorded from depths greater than 720 kms.

Non-Tectonic Earthquakes

These are due to volcanoes, movement of magma in the magma chamber, huge water falls, avalanches, huge landslides, tsunami. and meteoritic impact.

The Man Made Earthquakes

These are related to the energy released by nuclear and other type of explosions, collapse in underground mine(e.g. Rockbursts in Kolar Gold Fields), fluid injection or withdrawl at great depths, dams and associated reservoirs, quarrying. etc.

The Earthquakes, also are classified by the size of the event intensity (MM scale) or magnitude(Richter scale).

Table 6.2. The Modified Mercalli scale of seismic intensities.

Intensity	Description of characteristic effects
I.	Instrumental : detected only by seismographs
II.	Feeble : noticed only by sensitive people
III.	Slight : like the vibrations due to a passing lorry: felt by people at rest, especially on upper floor.
IV.	Moderate : felt by people while walking;rocking of loose objects, including standing vehicles
V.	Rather strong : felt generally; most sleepers are awakened and bells ring
VI.	Strong : All suspended objects swing. damage by overturning and fallling of loose objects.
VII.	Very strong general alarm; walls crack;plaster falls
VIII.	Destructive : car drivers seriously disturbed; masonry fissured; chimney fall; poorly constructed building damaged.
IX.	Ruinous : Some houses collapse where ground begins to crack, and pipes break.
X.	Disastrous : ground cracks badly ; many building and railway lines bent; landslides on steep slopes.
XI.	Very disastrous ; few buildings remain standing; bridges destroyed ; all services (railways, pipe and cables) out of action; great landslides and floods.
XII.	Catastrophic : total destruction; objects thrown into air; ground rises and fall in waves.

source : Duff 1992

6.8. DISTRIBUTION

The present geographic information indicates that earthquakes may occur any where in the world. However, a closer look shows that most of them are confined to well

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defined narrow belts and associated with plate boundaries and midoceanic ridges. The CIRCUM PACIFIC BELT, the major one, coincides with the Pacific plate boundary as well as with "Ring of Fire" . The western part of this belt, from Alaska runs south parallel to the Kurile, Japan, Marianas and Phillipine trenches which branches into two 1 . Karmadec, Tonga trench to the north- west of Newzealnd. 2. Java/ Indonesian trench. The eastern one follows the west coast of North America (mostly associated with San Andreas fault), continues southwards, parallel to middle American Trench and down to Andes which are associated with Chilean Trench. About 70 percent of the earthquakes reported are in the Circum Pacific belt.

Benioff seismic zone, first identified by Hugo Benioff(1949, 1954) in Pacific ocean trenches, is the subduction zone in Plate Tectonic Theory; It is also identified in the Burma - Andaman and Nicobar Islands - Indonesian Arc region where the Indian Plate(Indian Ocean Crust)subducts Eurasian Plate (Continent) ; Hugo Benioff opines that the dip of the benioff seismic zone is gentle, moderate, and steep for shallow intermediate and deep earthquakes, respectively.,

Table 6.3. Variations in the dips of Benioff zone

Earthquake	Depth	Dip
shallow foci	< 70 km	22^0
Intermediate	70-300 km	22^0 - 42^0 (33^0)
Deep foci	300-700 km	47^0 - 61^0 (60^0)

In the subduction zone, the magnitude of the earthquakes decreases with increase in depth of foci and age of subduction. In the benioff seismic zone the shallow earthquakes have high magnitude(7.75 M - 8.5 M) due to high stresses in the subduction plate consequent to bending as well as to fricitional movement developed in the rigid oceanic crust subducting in the last 2 million years. The intermediate earthquakes have less magnitude(7.0 - 7.7 M) because of reduction in frictional movement stress as a result of loss of rigidity in the subducting plate consequent of its metamorphism and partial melting. At 300 km depth, even though the subducting plate bends further 33^0 to 60^0, bending and frictional stresses will be less than in the shallow depth(<70 km) Because the subducting plate suffer greater melting and assimilation with depth and age of subduction (Depth : 300 km, 4 million years; 700 km, 10 million years) the deep earthquakes have least magnitudes (6.0 M - 6.9 M) in the Benioff Zone.

The second one, MEDITERRANEAN-TRANSASIATIC BELT, extends from west to east - north Africa, Europe, Turkey, The Caucuses, Iran, Pamirs, Himalaya, Tibet and China. A branch of this passes through Assam, Burma to East Indies. About 20 percent earthquakes reported are from this belt. Part of the remaining earthquakes are from mid-oceanic ridges(Divergent Plate Boundary) which are characterised by shallow earthquakes due to rift, lava extrusion, magma movement and associated transform faults. The balance, from the continental or oceanic part of the plates are due to release of accumulated stress consequent of plate movement. Because the Earth is one great system, the change at one point due to an earthquake will have repercussions at all points . This leads to a pattern of migration of earthquakes, which is unidirectional, if the after shocks are not considered.

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Distribution in india

Immediately after 1897 Great Assam earthquake, seismological observations were established at Alipore(Calcutta), Colaba(Bombay) and Madras(Later shifted to Kodaikanal). After 1905 Dharmshala(Panjab) earthquake, Agra and Dehradun; in 1922-23, Hyderabad stations were established. Initially the earthquake data was collected by Geological Survey of India and after 1936, Indian Meteorological Department looked after the seismological stations. After 1967 Koyna earthquake many new stations were established and new equipment was added from time to time in older stations. In Visakhapatnam a seismological station was established in 1960's.

Based on the available data (Geol.Surv. Inda, 1935, 1970; IMD) seismic zoning maps of India were prepared by Indian Standard Institute (Code No. IS.1893) in 1960 , 1966, 1970 and 1984. In IS. 1893-1984 map(Fig 6.5) there are only five zones(I to V) reduced from seven(O to VI) of 1960 and 1966 maps. The safe Zone is Zone ONE (Zone Zero in 1960 and 1966 maps) is one where earthquakes rarely occur. E.g. Zone One : Hyderabad area : ZONE TWO : Visakhapatnam; ZONE THREE : Godavari Valley - Rajahmundry ; ZONE FOUR : Kashmir, Jammu, Delhi, Roorke, Darjeeling area ; ZONE FIVE : Himalayas, Assam. The seismic zoning map is useful for the construction works like : dams, nuclear power plants, major industries. etc. The loss of human life with different earthquakes in India is shown in table 6.4.

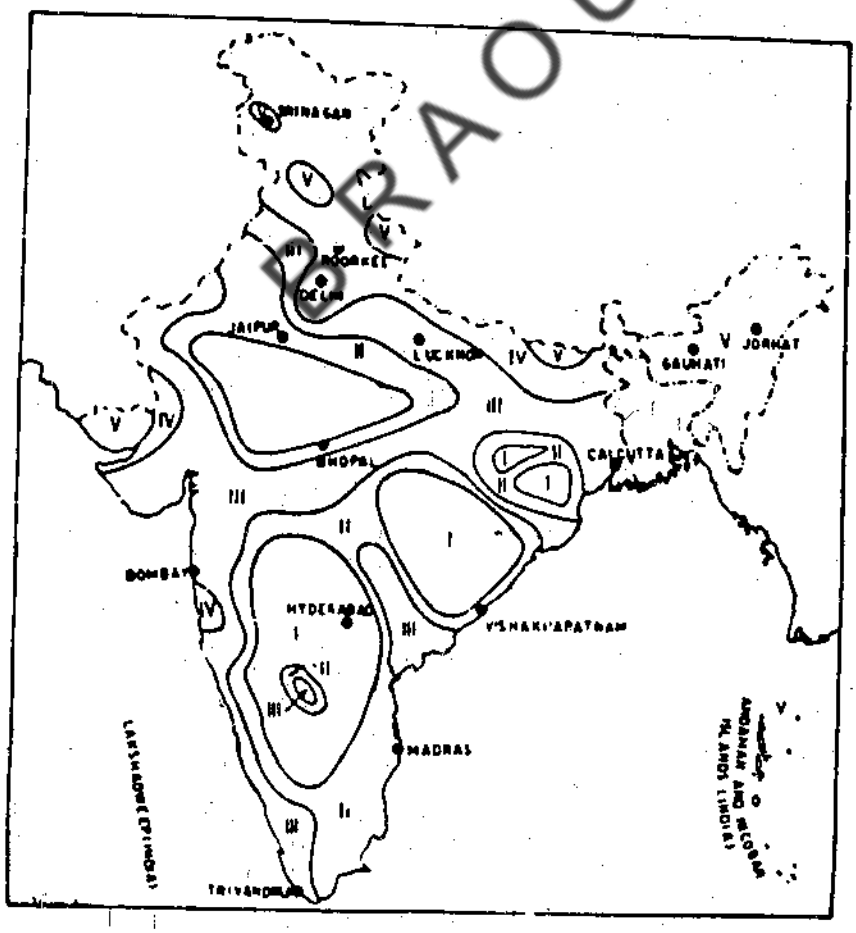

Fig. 6.5. Sciesmic zoning map of India (on lines of IS : 1893-1970).

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Table 6.4. Toll of human life due to earthquake in India

Year	Locality	Death Toll
1737	Calcutta	300,000
1819	Kachchh	15,000
1855	Badgam	3,000
1897	Maghalaya	1,600
1905	Kangra	19,000
1934	North Bihar	11,000
1935	Quetta	30,000
1950	N-E Arunachal Pradesh	1,500
1967	Koyna	200
1991	Uttarkashi	769
1993	Lathur	11,000

Check Your Progress 5 & 6

5. How man made earthquakes can occur.

6. Write down the depths of shallow foci, Intermediate foci and deep fold Earthquakes.

Note : (a) Write your answers in space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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6.9. ENVIRONMENTAL IMPACTS

Earthquakes are destructive natural hazards. With increase in population, people are forced to habitat in more and more inhospitable areas. Hence, the effects of earthquakes increase exponentially. The hazards associated with earthquakes are : the phenomena of ground shaking, surface faulting, earthquake induced ground failures and tsunami. Reservoir induced seismicity is man made and detailed studies have been undertaken in India, after 1967 Koyna earthquake. The study of earthquakes has thrown light on internal structure of the earth and also, contributed to the development of seismic prospecting (e.g. oil, etc) and earthquake engineering.

Ground Shaking

This is caused by body(P and S) and surface (R and L) waves. They cause the ground to vibrate with frequencies of about 0.1 to 30 Hertz. The civil structures vibrate as a consequence of ground shaking and the damage depends on the age and design of them. The body waves causes high frequency (greater than 1 Hertz) vibrations that

cause more damage to low civil structures than the surface waves. The amplitude of the surface waves decay less rapidly than body waves, with distance from the focus. The former can damage toll civil structures near and far away (say 100 km) from the focus. The great damage of different structures recorded in 1967 Koyna, 1991 Uttarakashi and 1993 Lathur earthquakes is all due to poor construction. It is so, any where in the world.

Mitigation : It is possible to reduce the damage in earthquake belts by landuse zoning, use of frequency of earthquakes and their parameters in civil constructions. In Japan, the traditional civil construction is light weight but due to population increase, after second world war, the earthquake resistant designs are developed and implemented.

Surface faulting

This is differential movement caused by deep seated forces in the earth. It causes damage to the civil structures, particularly to transport lines and pipe lines The area subject to distruption of surface faulting varies with the displacement, length and width of rupture zone as well as on mechanical properties of rocks and soils of the area. Also, subsidiary and separate fault ruptures can occur. Most of the historically recorded surface faulting is associated with Holocene and Quarternary faulting. Faults can lie dormant for many thousands of years between periods of vigorous activity (e.g.1897 Assam earthquake. Chedrang Fault)

Mitigation : It is possible to reduce the effect by landuse zoning in the fault zone by accurate location of the fault and an assessment of its history of activity through detailed geologic examination (e.g.San Andreas fault, California, U.S.A.; Macro faults of Himalayas). All precautionary measures must be taken in the construction of structures dams and associated reservoirs, bridges, aqueducts, roads and railways - as it is not possible to avoid faults.

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Earthquake Induced ground failures

These are the results of liquefaction of clay of free soils during some earthquakes. Liquefaction is a physical process wherein the sands and silts behave as viscous fluids than solids. Liquefaction takes place when seismic shear waves pass through a saturated granular soil layer. Distruption in the soil generated by the collapse of voids cause transfer of the load to the pore water. This transfer of load increases pore water pressure which gets released when there is drainage. If drainage is restricted or absent, a sudden build-up of pore-water pressure caused by the weight of the column of soil will change the granular soil layer into a fluid, for a short period. Then, liquefaction causes three types of ground failures, lateral spreads, flow failures, and loss of bearing strength. Also, it enhances ground settlement and sometimes generates sand boils(fountains of water and sediment emanating from the pressurized liquefied zone). The sand boils can cause local flooding and deposition or accumulation of silts(e.g. 1934 Bihar earthquake) Liquefaction is observed mainly in areas of sands and silts deposited in the last 10,000 years and where ground water table is within 30 feet of surface (e.g. Slump belt, 1934 Bihar earthquake). Clays in general, and in particular lose strength and may fail due to ground shaking.

Lateral spread : This involves the lateral movement of large block of soil as a result of liquefaction in a subsurface layer, They generally develop on gentle slopes, most

commonly on those between 0.3 and 3 degrees. Horizontal movements on lateral spreads commonly are as much as 10 to 15 feet. If the ground shaking is for a longer duration on favorable slopes, lateral movement can reach 100 to 150 feet. Lateral spread usually break up internally, forming numerous fissures and scarps. The damage caused by lateral spreads in generally disruptive and particularly destructive to pipe lines, bridges, flyovers, etc.

Flow Failures : These are made up of liquefied soil or blocks of intact material riding on a layer of liquefied soil, are the most catastrophic type of ground failures caused by liquefaction. They are observed on land and underwater, the quantity and velocity of travel of a flow failure is related to the slope(3 degrees) and energy of the earthquake. Many of the largest and most damaging flow failures are recorded in underwater of coastal areas(e.g.1964 Prince William Sound earthquake). These submarine flow failure, in turn, generate large sea waves(Tsunami) that overrun parts of the coastal area, causing additional damage and casualties. Flow failures on land are also catastrophic. The 1920 Kansu earthquake(China) caused many flow failures of 1 mile in length and breadth, which killed about 200,000 people. Loss of bearing strength is observed in soils supporting a building or some other structure as a result of liquefaction. Hence, deformation can occur within the soil, allowing the structure to settle and or incline(e.g. 1934 Bihar earthquake, India)

Mitigation : The damage due to ground shaking can be mitigated by land use zoning prevention techniques for liquefaction and ground failure, deep and displacement - resistant foundations. The techniques to stabilize a site against liquefaction are : compaction, grouting or drainage of susceptible soils. The displacement - resistant foundation is possible for one foot (e.g. Lotus Temple, Net Delhi)

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Landslides

Landsides of different types are associated with the earthquakes. The most abundant are rock falls and slides on steep slopes. The less abundant are : shallow debris slides on steep slopes ; soil and rock slumps, and block slides on moderate to steep slopes (e.g. Koyna region : Patan taluk, Satara district).The large scale landslides are rock avalanches, soil avalanches and underwater slides. Rock avalanches originate on over steepened slopes in weak rocks (e.g.1970 Peruvian earth-quake. Single rock avalanche, 18,000 people died.) Soil avalanches are observed in some weakly cemented fine grained materials, such as loess, that form steep stable slopes under nonseismic conditions(e.g. 1811 - 12 New Madrid, Missouri earthquake) Under water landslides occur at the margins of deltas(e.g.1964 Seward earthquake Alaska). The spatial extent of the affect as a result of earthquake induced landslide depends on the parameters of the earthquake, topography, soils, geology and duration of ground shaking.

Mitigation : The land use zoining and prevention of excevation are essential for stabilizing areas susceptiable to landslides.

All the above earthquake effects are observed, well recorded and published for 1819 Cutch, 1899 Assam, 1905 Kangra and 1934 Bihar - Nepal eqrthquakes

Tsunami

This consists of giant sea waves often associated with earthquakes of high magnitude

are caused by displacement of water due to sudden large-scale changes of level of the sea floor as a result of fault movement or submarine slumping due to the earthquake or exception of a volcano in the ocean. The inward movement of vast volume of moving water due to sudden downward displacement of ocean floor or vice versa, carries sea water in all directions as ebb and flow in the form of a long wavelength (hundards of kilometers) oscillating waves in deep water. These waves travel at speeds of a few hundred kilometres (e.g.aAt water Depth : 5 km speed 7000 km per hour) with a wave height of about 1 metre in deep waters. When these waves reach shallow waters around islands or continental shelf, they pile up and rise to heights of 20/30 metres swiftly as their speed decreases with decrease in depth. Thus tsunami move inland and cause destruction far from the area of its generation. The recent data indicate that submarine earthquakes will greater than 8 magnitudes are invariably followed by a tsunami. However, the low islands of the Pacific and mid oceanic atolls do not suffer damage due to tsunami as a result of their steep rise from the sea floor and having diameter less than the wavelength of tsunami in deep water.

Mitigation : The best way of mitigating is a Tsunami warning System (Seismological stations with Satellite Communication Network, T.V. and Radio) that give many hours of advance notice for evacuation purposes. Land use zoning of coastal areas based on the expected wave heights from the historical records also reduce losses from it .

Check Your Progress 7 & 8

7. How surface faulting will occur.

8. What is Tsunami and how it will occur.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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6.10. RESERVOIR-INDUCED SEISMICITY (RIS)

D.S.Carder, in 1945, is the first to correlate the Lake mead(U.S.A.) loading and seismicity in the Boulder alias Hoover dam area, Colorado, U.S.A. The 1967 Koyna earthquake(M:6.3) is the most significant one associated with loading of Shivaji Sagar reservoir associated with Koyna dam, Maharastra. H.K. Gupta, B.K. Rastogi and few other Indian Scientists studied the RIS in India, Koyna dam is the best site in the world for RIS and there are more than 125 recording of magnitude between 3.9 and 6.0 form 1967 to date. Besides the listed (Table 6.5) Seismicity is reported from dam areas-Kinnerasani, Parambikulam, Sharavathi, Bhandra, Ukai, Ghirni Mangalam, Sholayar and Osman Sagar. However, there is no evidence of RIS in the 9 impounded reservoirs

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of the H„ in the foot hills of Himalayas, Non-occurrence of RIS in these is primarily due to thrust fault environment and the presence of thick pile of rock mechanically incompetent sedimentaries(10 km thickness) which do not accumulate stress to the critical levels to be triggered by reservoir loading. However, the dams in Himalayan region are in the plate boundary and therefore, exposed to natural earthquakes.

Table 6.5. Reservoir induced seismicity in India

1	2	3	4	5	6
Koyna, Maharastra	103	2,780	1962	1967	6.3
Bhatsa, Maharashtra	88	947	1981	1983	4.9
Gandipet, A.P	36	117	1920	1982	3.5
Idukki, Kerala	169	1,916	1975	1977	3.5
Mula, Maharashtra	56	1,054	1972	1972	1.0
Sriramsagar,A.P	43	32,000	1983	1984	3.2

1. Name of the Dam/reservoir 2. Height of the dam(m)
3. Reservoir Volume($10^6 m^3$) 4. Year of impounding
5. Year of the largest earthquake 6. Magnitude

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6.11. EARTHQUAKE PREDICTION

The objective of the prediction is to find the size, time and location of earthquake, to reduce the human suffering. It is possible to predict earthquakes, if not all, based on the available data, The disciplines of earthquake prediction research are : geodetic work, tide gauge observation, continuous observations of crustal movement, seismic activity and seismological method, seismic wave velocity, geotectonics, gravity surveys, radon and helium surveys, animal and bird behavior, ground water levels, and astrology. As the loss due to earthquake destruction increase multifold with increase in population and human investments, any amount of money spent on prediction techniques is worth more than its value. In 1967, working group on earthquake predication(W.G.E.P) was established under the aegis of the International Union of Geodesy and Geophysics(I.U.G.G)

Forecast Region : Varahamihira(6th Century A.D) in his book 'Brhatsamhita' (in Sanskrit) demarcated earthquake zone in India. K.N.Khatri(1983) identified 24 seismic source zones in Indian sub-continent, based on the geological structures, seismic source zones, and seismicity conditions. (Fig 6.6) The Indian standard Institute prepared Seismic zoning map of India in 1962, 1966, and 1970 . These will help to identify a ' Forecast Region' . The other methods will be used to identify the 'Prediction Area' in the 'Forecast Region'.

Geodetic work : This measures the deformation of land which is generally accompanied by a large - scale earthquake. J.A Mesherikov, after 1966 Tashkent earthquake, identified three phases of crustal movement in seismic regions. They are : 1) slow movement revealed during the cycle between the bursts of seismic activity (α phase); 2) Pre-seismic crustal movement of earthquake (β phase) and 3) movement caused

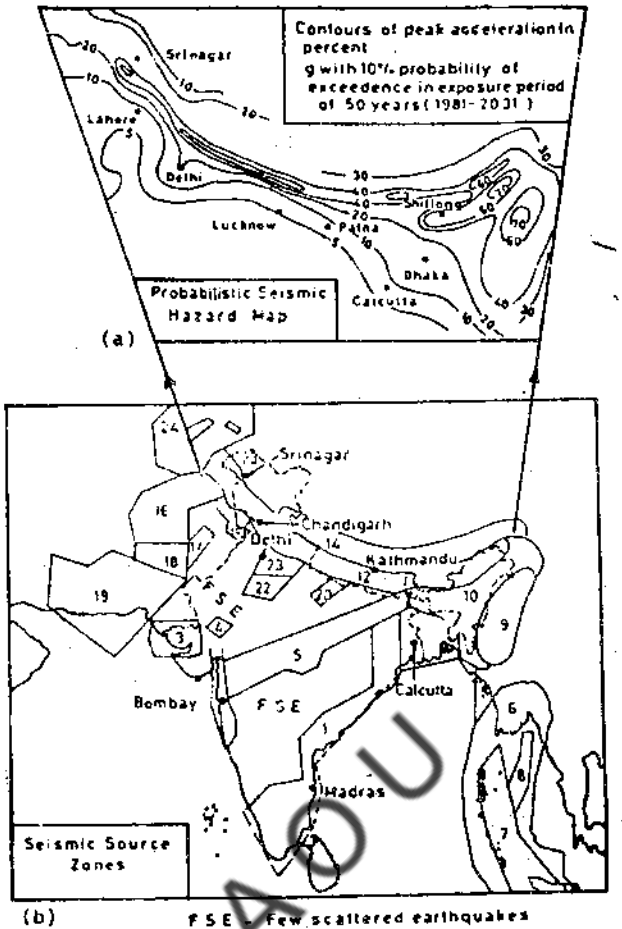

Fig. 6.6. The seismic source zones identified by K.N. Khattri (1983) on the basis of geological structures and past and present seismicity conditions. The inset shows an epoch-dependent probabilistic seismic hazard map of the Himalayan seismic source zone. It is prepared on the basis of the relationship between peak ground-acceleration versus maximum magnitude. The contours indicate peak acceleration given in terms of % g.) Source : Environmental Geology. Indian Context by K. S. Valdiya, Publisher : Tata McGraw Hill, New Delhi.

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by earthquake (γ phase). The Deformation is measured by levelling surveys, triangulation and geodimeter work : Levelling surveys are being carried out in Japan from 1889 and deformation is observed with earth quakes. Repetition of levelling surveys, in the forecast region, is one of the most powerful means for indicating a probable seismic event in the future. Triangulation surveys are being done by survey of India and based on them all maps are being published. It is possible to identify land deformation in the seismically active areas by repetitive triangulation surveys of the forecast area every 5 years. The use of modern geodimeter which measures a distance of 20 km with a precision of one part in 100,000 enables to repeat surveys equivalent to triangulation with much shorter time interval.

Tide gauge observations : These indicate changes in sea level. They were errected in all the ports of India. Many continuous recording tide gauges with wind and pressure gauges are needed to predict earth quakes in the coastal region.

Continuous Observation of Crustal Movement : This movement is carried out by tiltmeters and extensometers.

Tiltmeter : Horizontal pendulum type, is very sensitive to local disturbances. Electronic tiltmeters in an array of 40m/100m arranged in a underground tunnel to

measure tilt. The data collected so far are promising, the tiltmeter measurements will become useful in detecting seismic event.

Seismic activity and seismological Method : The development seismometry made it possible to measure microearthquakes (3>M1) and ultra-micro earth quakes(1>M) . The study of seismological data pertaining to the strain release and magnitude of the earth quakes indicated the following tow points 1) The regional pattern of microearthquake activity is grossly similar to the seismicity pattern of larger earthquakes; 2) The response of the crust to regional tectonic stress differs from place to place even in the same general tectonic area, resulting in a complex pattern of strain concentration and microearthquake activity.

Geotectonic studies : This include identification of active faults with the help of satellite imagery, aerial photographs, field geology, and geomorphology. Many types of observations will be made in and around the fault zone for earthquake prediction.

Geomagnetic and Geoelectric Methods : This phenomena have relationship to earthquakes. The modern high accuracy magnetometer data will help to predict earth quakes as there is interrelationship between magnetic event and creep displacement. The repetitive geomagnetic surveys will help in earthquake prediction. The earth-current versus earthquakes are being studied for prediction purposes.

Other Methods :

i) The measurement of radon which increases before the earthquake in ground and spring water before the earthquake is a good tool for prediction (e.g.1966 Tashkent earthquake).

ii) The Chinese Scientists used animal behavior, and water table fluctuations and foreshoks in predicting 1975 Haicheng earthquake(M 7.3)

iii) The conjunctive use of animal behavior with geophysical surveys resulted in successful prediction of 1976 August Songpan - Pingwa (Szechuan Province, China) earthquake as well as 1976 November Yunan Earthquake(China).

iv) The building of elastic strain after an earthquake in area takes time to accumulate as a consequence of geologic processes. For example, L.Seeber and J.Armbruster(1981) based on the 80 years data, concluded that on the average one great earthquake (M > 8) can be expected every 30 years in the Himalayan zone. The mostly likely locations for such earthquakes can be in the following gaps identified by Khatri and others(inValdiya, 1987): the 500 km long Jammu gap west of the 1905 Kangra epicentre ; the 900 km long Kumaon Nepal gap between 1905 Kangra and 1934 Bihar epicentres ; and the 240 km wide Assam gap between the epicentres of 1934 Bihar and 1950 Assam earth quakes.

v) Laboratory work on wave velocities in rocks under high pressures, piezomagnetic effect, electrical resistivity, etc. are being developed earthquake prediction.

vi) Krishnabrahmam(1993) showed that the epicentres of earth quakes in South India fall in the gravity low or high anomaly areas. According to Reddi (1995) heat flow with gravity will help to identify stress accumulation areas to predict earth quakes and drilling for more data collection.

Prediction of reservoir-induced earthquakes : The seismicity near the man-made reservoirs is dependent on the rate of increase of water level, duration of loading,

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maximum water level reached, duration of storage at high water level and rate of discharge. Most of the RIS recorded, have their focus with in a radius of 25 km from the deepest portion of the reservoir . Recognition of foreshocks as precedent to a RIE is very important for its prediction. Now a days the seismic data is transmitted by satellite and by other means to processing centres for earthquake prediction. For example, the ultra High Frequency(UHF) transmeter at Bhatsa dam(9) km. NE of Bombay on the Bhatsa river) transmits seismic data to BARC,Bombay, Finally, the implementation of prediction depends on decision makers, scientists, administrators, people.

Check Your Progress 9 & 10

9. What is geodetic work ?

10.What are the instruments used to observe crustal movement ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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6.12. SUMMARY

Earthquake is a vibration or oscillation of the surface of the earth for a few seconds caused by a transient disturbance of the rocks at or beneath the surface. Seismology is the science of earthquake and related phenomena. Earthquakes are mainly due to release of stress from Rock masses by natural process or due to man made structures. The natural phenomena are landslides, avalanches, collapse of caverns, volcanic eruptions, mountains of magma etc. Earthquakes with human activity are explosions, dams and reservoirs, mining etc. Earthquake waves are called seismic waves, which are recorded with a seismograph. Body waves are the longitudinal waves and transverse waves. Surface waves are the love waves, stonely waves and channel waves.

Focus (Hypocentre) is the place of origin of disturbance that caused an earthquake. The point above the focus and on earth's surface is called epicentre and the area of the maximum damage around it depends on earthquake magnitude. The earthquakes, are classified as tectonic , nontecnic and man made earthquakes, and also are classified by the size of the event, intensity (MM Scale) or magnitude (Richter scale).

The hazards associated with earthquakes are the ground shaking, surface faulting, earthquake induced ground failures and Tsunami. Ground shaking can be avoided by zoning of such areas and construction of light weight civil constructions. surface faulting can not be avoided totally but zoning of such fault zones and suitable precautionary measures in the design of dams, reservoirs, roads etc will help to avoid large scale damage. In case of landslides the land use zoning and prevention of excavation are useful to avoid damage, The best way to avoid tsunami is through

warning system with communication network like T.V. Radio etc.

Earthquake prediction cab be done with geodetic work, tide gaugage observation, continuous observation of crustal movement, seismic activity and seismological method, seismic wave velocity, geotechniques, gravity survey, radon and helium surveys, animal and bird behavior, water levels and astrology.

6.13. CHECK YOUR PROGRESS : MODEL ANSWERS

1. An earthquake is a vibration or oscillation of the surface of the earth for a few seconds.
2. P ways are compression dilation waves and vibrate parallel to the direction of propagation and passes through gases, liquids and solids and are similar to sound wave,where as S- wave particles vibrate at right angles to the direction of propagation and can not passes through liquids and are similar to light waves.
3. Chang Heng(Chinese astronomer) in 132 A.D first developed the seismoscope to record earthquakes.
4. Focus is the place where earthquake origin and epicentre is the point above the focus on the surface of earth.
5. Man made earthquakes will occur with nuclear and other type of explosions collapse of underground mine, fluid injection or withdrawl at great depth, construction of dams and associated reservoirs, quarrying etc.
6. The depth of shallow foci earthquake may be less than 70 km, intermediate foci earthquake may be between 70 and 300 km and deep foci earthquake may be in between 300-700 km.
7. Surface faulting will occur with the differential movement caused by deep seated forces in the earth.
8. Tsunami is a great sea wave associated with earthquakes of high magnitude and will occur by displacement of water due to sudden large scale changes of level of the sea floors.
9. Geodetic work measures the deformation of land which is generally accompanied by large- scale earthquake.
10. Tiltmeter and extensometers are using to observe crustal movements.

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6.14. MODEL EXAMINATION QUESTIONS

I. Answer the following in 30 lines.

1. What is an earthquake and write down about earthquake waves.
2. Write an essay on the distribution of earthquakes in the world.
3. Write the environmental impacts with earthquakes and how these can be mitigated.

II. Answer the following in 10 lines.

1. What are seismographs.
2. Classify earthquakes.
3. Write about earthquake prediction.

Prof. V.R.R.M. Babu

UNIT-7: HILL SLOPES - LANDSLIDES-SNOWY MOUNTAINS

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  7.3.5. Controlling Methods of Landslides
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7.1. OBJECTIVES

After completion of this unit, your should be able to :

* describe the classification of landslides,
* define mass movement - subsidence,
* explain about avalanches,
* describe the controlling measures of landslides.

7.2. INTRODUCTION

The natural environmental disturbances like earthquakes, landslides, volcanoes, floods, cyclones, drought, etc. are occurring frequently in different parts of the world. Such events are causing damage to nature and mankind so, it is important to know the exact reasons to such disturbances in order to take necessary preventive and precautionary measures in future. In this unit our main emphasis is given on landslides, subsidence and also on avalanching in snowy mountains. In our country, these activities are seen along Himalayas and also along the mountain or hill peaks. The avalanching is mainly seen in Himalayas only. Such incidents are causing large scale destruction of man made things like bridges, buildings, roads etc. and also causing loss of life. In general large scale loss of life is not reported recently, but historical records shows such incidents like the fall of Mount Granier in 1248 A.D. and the slide of Rossberg in Switzerland.

The geologist/geophysist will study and analyse the mass movements, landslides subsidence and avalanching. The civil engineer for their planning of large structures will depend on the expertise of geologist to overcome environmental degradation.

7.3. HILLSLOPES AND LANDSLIDES

Hillslopes are the prime areas of landslides. The fact is that, the internal heat of the earth drives mountain building process, and gravity acts to tear the geological materials down. The gravity plays major role along the hillslopes because of slopy nature. The downward pull of geological materials along the hillslopes can be seen everywhere on earth. This activity is causing a variety of phenomena collectively called as mass washing or mass movement, by which the materials are moving downslope, from one place to other. The movement may be slow, subtle, almost undetectable on a day to day basis, but cummulatively large over days or years. If the nature of movement is sudden as in a rockslide or avalance devastation is obvious.

Landslide is a general term for the result of rapid mass movement. overall landslide damage is probably greater than one might imagine from the usually brief coverage of landslides in the news media.

7.3.1. Landslide Prone Areas in India

In our country in the mountain regions of Nilagiries and Himalayas the problem of hillslide instability is very serious. These are the locations where landslides are very common because these zones and areas are repeatedly rocked by earthquakes and effected by neotectonic activities. As quoted by K.S. Valdiya in his book "Environmental Geology, Darziling Himalaya recorded more than 20,000 landslides in one day. The Himalayas are the geodynamically sensitive and seismically, the most active segment of the Indian sub-continent, its northeastern and northwestern ends being repeatedly and violently rocked by earth movements. The population explosion forcing the people to moveup the hillslope with their plughs and livestock. Deforestation by this human settlements had to erosion and mass movement , ultimately causing environmental degradation. This type of situation prevails on the valnerable slopes of Nilgiri - Annamudi massif in South India.

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7.3.2. Mass Movement

The movement of soil/rock materials along the hillslopes is mass movement or mass washing . The three important process for such activity are the 1) Heavy and prolonged rain fall2) Cutting and deep exacavations on slopes for building, cannals, roads and mining 3) Earthquake shocks and tremors. At the same time mass movement can not occur without any reasonable cause. The causes are several, and shows independent action or combination of two or more. The important causes are as given below.

I. Effects of slope

Slopes, because of its exposure to natural erosional process by wind, water or ice influences mass movement. Slopes may contain different types of rock fragments in different sizes. Some will withstand for steeper angles, the remaining will go down by gravity as mass movement. The erosion process can undercut rock or soil, removing the support beneath a mass of material, ultimately the overlain material joins mass movement. This is common factor to landslide in coastal areas. over a long period of time, the slow tectonic deformation along slopes also cause mass movement as shown in fig 7.1. The angle of repose of rock material with fine material cause more mass movement than coarse material.

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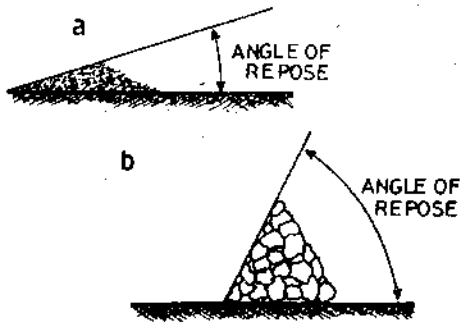

Fig. 7.1. Angle of repose (a) Finer rounder particles can sustain only low slope angle. (b) Coarse irregular particles can be more steeplypiled.

II. Effect of rock material types

The rock or earth material cause mass movement depending upon hardness and weakness. when- ever hardrocks of very resistant nature like sandstone overlies low resistant weak rocks like shale due to rapid undercutting mass movement will occur in the form of rotational sliding (Fig. 7.2 a). Along the geological planes of weakness such as fractures, bedding planes and foliation planes translational slide will occur (Fig.7.2 b). Soil slip type of mass movement can be occur where colluviam lies in between soil and hard bed rock (Fig. 7.2c).

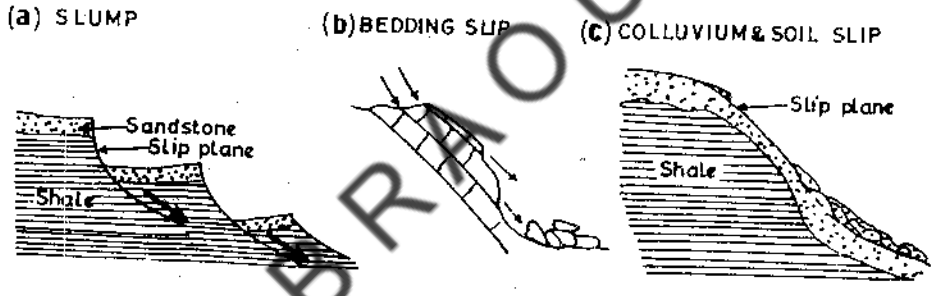

Fig. 7.2. Rotational (a) and translational slides (b & c).

III. Role of climate and vegetation

Climate is significant for mass movement because it controls precipitation and moisture content in slope materials . For example both earth flows and mud flows, involves down slope movement of water - saturated earth movements.

Vegetation is a significant factor in slope stability. Vegetation of slopes controls mass movement by the activities of covering the soils, development of cohesion to slope materials with roots and adds weight to the slope. If vegetation is absent, the activity of mass movement is maximum.

IV. Role of water

The water is almost directly or indirectly involved with landslides. Water is a universal solvent and is useful for rock weathering. In this process water takes away in loose material dissloved in it as mass movement. Along the hillslope due to heavy rains water gets percolate, and after exceeding limits starts run-off. In this process the slope materials become weak which leads to landsliding and mass movements. The with-drawal of water from reservoirs may also cause landslides owing to the change in the balance. Seewage of water from artifical sources, such as reservoirs, swimming pools,

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cannals and septic tanks, into adjacent slopes may also affect slope stability and then cause mass movement. Stream or wave erosion may remove and steepen the slope and cause mass movement.

V. Role of Earthquakes

Earthquake shocks particularly those of shorter duration cause mass movement. Extensive landslides caused by the 1950 earthquake in eastern Arunachal Pradesh, and by 1934 Bihar earthquake bears testimony to this fact. The vibration generated by the passage of heavy vehicles create oscillations of different frequency in the rocks and thus change the stress pattern, reducing shear strength and causing mass movement.

VI. Role of Human activities

Many types of civil works like highway, road cuts, quarrying or open - pit mining construction of stepped home building sites on hill sides may cause mass wasting.

Check Your Progress 1 & 2

1. List any two landslides prone areas in India.
2. What are the causes of mass movement.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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7.3.3. Classification and types of landslides

Classification

Minor earth movements will be considered, for convenience, under two headings "landslides" and "Rock falls," the latter term includes sudden falls of solid rock, and the former, covers all other types of localized earth movement except subsidence. Landslides are so common and are often so serious in their effects, they have been the object of much study. Two governments the Swiss and Italian mountain official organisation are dealing with landslides.

In many of these studies, attempts have been made to classifify landslides. In order to simplify their investigations, the classification of Heim and Berzangi are perhaps the best known. In this brief review, detailed classification cannot be followed; reference may, however, be made to an exceedingly useful volume published by United States High Way Research Board as its special Report No.29(1958).

Type of Movement	Type of Material			
	Bed Rock		Soils	
Falls	Rock Fall		Soil fall	
Few units Slides many units	Rotational	slump Placer Block glide	Placer Block guide	Rotational Slump
		Rock Slide	Debris failure by slide lateral spreading	
Dry flows	Rock frequent flow sand run losses below		Sand or silt mixed mostly plastic	
Wet	Rapid earth flow sand or	Debris avalanches debris flow		Slow earth flow Mud flow

Many classifications have been suggested for mass movements. According to Sharpe's classification, mass failure is devided into four major groups on the basis of type of failure. Each group is further subdivided into classes on the basis of rate of movement, nature of the mass and defect of saturation(Fig. 7.3).

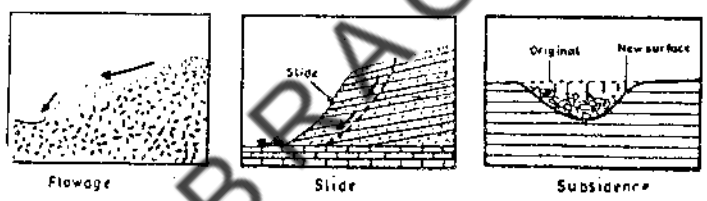

Fig. 7.3. (a) flowage (b) Slide (c) Subsidence

A Slow Flowage	B Rapid Flowage	C Sliding	D Subsidence
1.Rock creep 2. Soil creep 3. Solifluction	1. Earth flows 2. Mud flows 3.Avalanches	1.Slump 2.Rock slides 3.Rock fall 4.Debris slides 5. Debris fall	Sinking of the mass

Types : 1. Creeps or soil creep: It is a type of slow flowage and consists of gradual, almost imperceptible down grade transit of soil. It may be found in regions of diverse climates but it is particularly common in cold wind slopes. Frost action favours soil creep in particular with the passage of time, huge quantities of soil mass may be brought down and accumulated at the base of the slope. A careful observation of facts like bending of rock beds, their disjointing, disruption and drag folding are characteristic features of a creeping mass. Tilted trees, poles and fenses, upslope curvature of tree stems, bulging of retaining walls etc. are indicative of creep, movement seen on

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a number of hillslopes of the *Nain lake* in the Kumaun Himalaya (Fig 7.4).

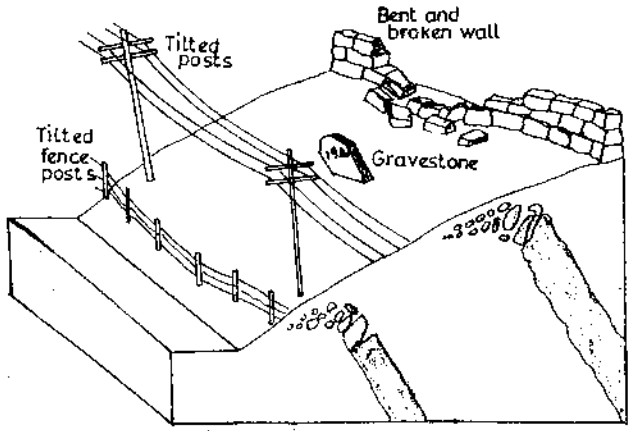

Fig. 7.4. Signs of sliding broken wall and tilted poles, gravestone, fence posts.

2. Earth and Mud flows : These are rapid type of mass movement confined mostly to open textured soils or unconsolidated rocks which takes place usually after heavy rains or heavy melting ice. Clays on becoming wet are rendered plastic and start almost slipping under their own load in the presence of water. The terms earth flows and mud flows simply distinguish two types of the same flow with different water content. In mud flows the quantity of the water is very high so that the whole mass is reduced to a slush or mud. Mudflows are commonly witnessed in the Siwalik terrain and along the western ghats.

A special type of earthflow is seen in high glacial areas resulting from thrawing of ice that falls the intergranular space within clays. As the ice melts, the whole mass becomes water logged and unstable leading eventually to downslope flow called solifluction.

3. Slumps and Slides : In a slide, a fairly cohesive unit of rock or soil slip downward along a clearly defined surface or plane. Rockslides most often involves movement along a bedding plane between successive layers of sedimentary rocks, or slippage where differences in original composition of the sedimentary layers measuring in a weakened layer or a surface with little cohesin(Fig 7.5). If the rock block do not move very far, the slide may be called a slum. Slumps also occur in soil. In this case, a rotational movement of the soil mass typically accompanies the downslope movement.

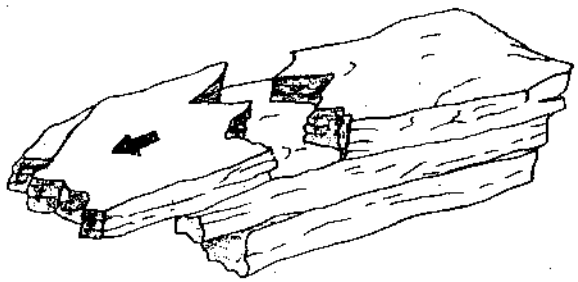

Fig. 7.5. Rockslide

4. Falls : A fall is a free falling action in which the moving material is not always in contact with the ground below. Falls are most often rock falls (Fig.7.6). They

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frequently occur on very steep slopes when rocks high on the slope, weakened and broken up by weathering. Loose sand materials are eroded away. Falls are common along rocky coastlines where cliffs are under cut by wave action and also at road cuts through soild rock. Rockfalls are very common along the Jammu-Srinagar highway.

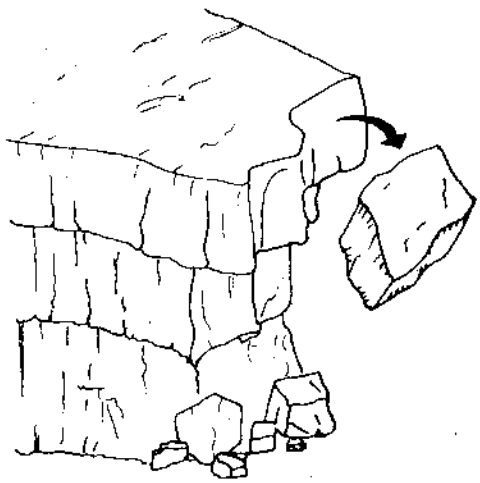

Fig. 7.6. Rockfall

7.3.4. Identification of Landslide Zones

Identification of areas with a high potential for landslides is the first step in developing plan to avoid landslide hazards. This is done on the basis of geomorphic feature revealing past history and indicating existing stress and recognition of the destablizing effect, involves comperhensive investigation embracing : a) detail of structural and lithological setting b) geophysical features with special emphasis on those relating to instability of slopes c) seismicity pattern of the region d) signs of instability such as cracks on the ground and walls, falling of trees and poles, leakage of under ground pipes. etc. e) determination of cohesion and strength of the soil.

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On the basis of severity of landslides and other manifestations of mass movements, the landslide hazard zoning maps are prepared with four zones of instability : 1. very unstable zone 2. moderately unstable zone 3. moderately stable zone and 4. stable zone.

7.3.5. Control of Landslides

Many methods for controlling the landslides are available and choice of any method will depend on factors like nature of slide; the underlying cause for it, the nature and amount of material involved and the economic considerations. Out of such methods, most important are i) drainage control ii) retention structures iii) slope reduction iv) vegetating damaged slopes and v) slope stabilization measures.

Drainage controls : It involves the removal of moisture from wihin the rocks as well as preventing any further moisture to approach the material susceptibe to sliding. This may be achieved either by surface drainage or by subsurface drainage or by both the methods . Construction of interception ditches, water ways, trenches and drainage tunnels may be necessary. (Fig 7.7)

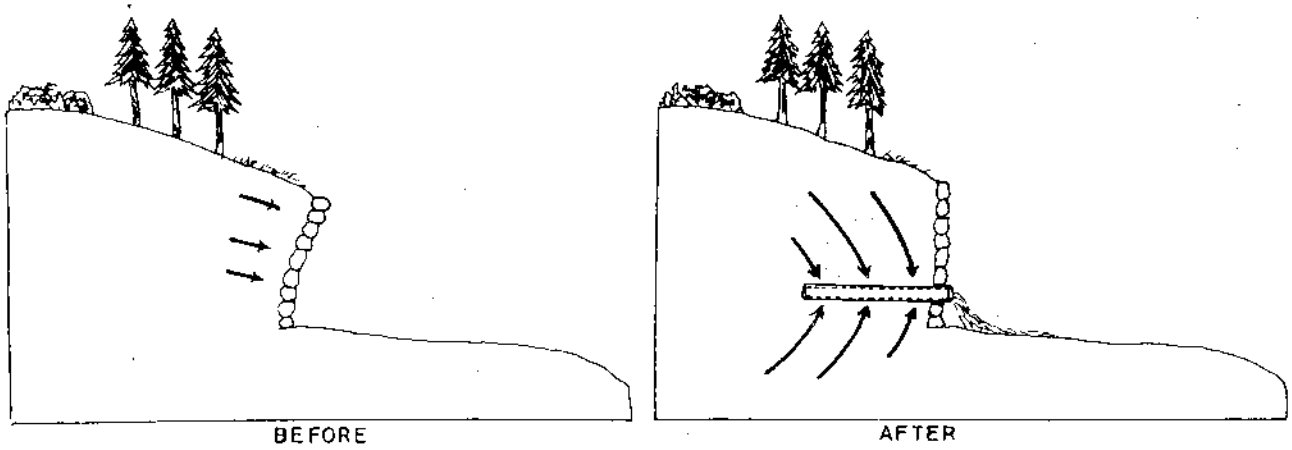

Fig. 7.7. Dewatering to reduce pore pressure and load.

Retention structures : All such devices like construction of retaining walls are aimed at stoping the moving mass by force and their success is always doubtful. Construction of successful retaining walls required an accurate assessment of the force which the wall has to withstand.

Retaining walls may prove exceptionally successful where a) the ground is neither fine nor plastic, b) the sliding mass is likely to remain dry and c) the movement is of shallow nature.

Slope Reduction : If a slope is too steep to be stable under the load it carries, any of the following steps will reduce slide potential : 1) reduce the slope angle 2) place additional supporting material at the foot-slope 3) reduce the load on the slope, by removing some of the rock to soil high on the slope (fig. 7.8).

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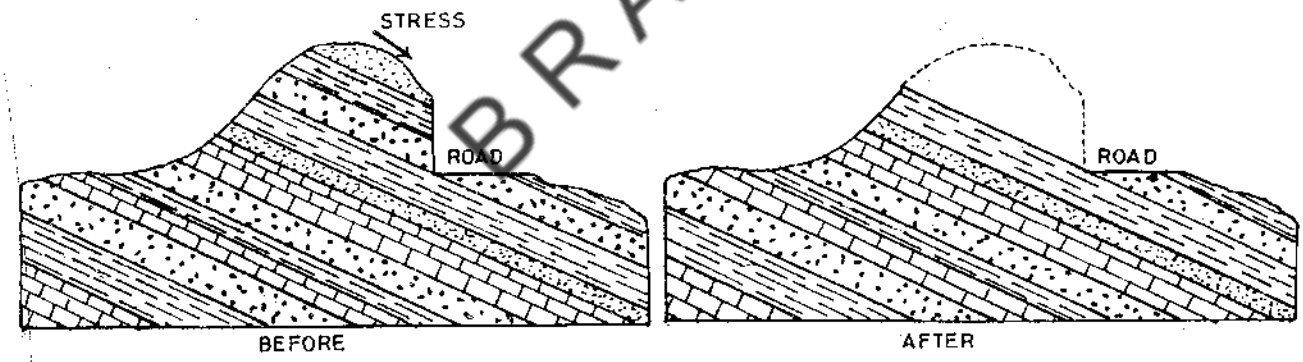

Fig. 7.8. Slope stabilization by slope reduction and removal of unstable material along road cut.

Aforestation : The growth of vegetation useful in the stabilizing the barren slopes. Grasses have been found useful for protecting slopes, such as nara 'timonograss', 'napior', 'kikiyu', 'jonda' etc., the choice will be depending on local conditions including climate and soil composition. The legume with deep roots has been found very promising.

Other slope stabilization measures : Techniques useful are the driving of vertical piles into the foot of a shallow slide to hold the sliding block in place. The use of rock bolts to stabilize rocky slopes and occasionally, rock slides had greater success (Fig 7.9). Rock bolts have long been used in tunneling and mixing to stabilize rock walls. It is sometimes also possible to anchor a rock slide with joint steel bolts driven into stable rocks below the slip place.

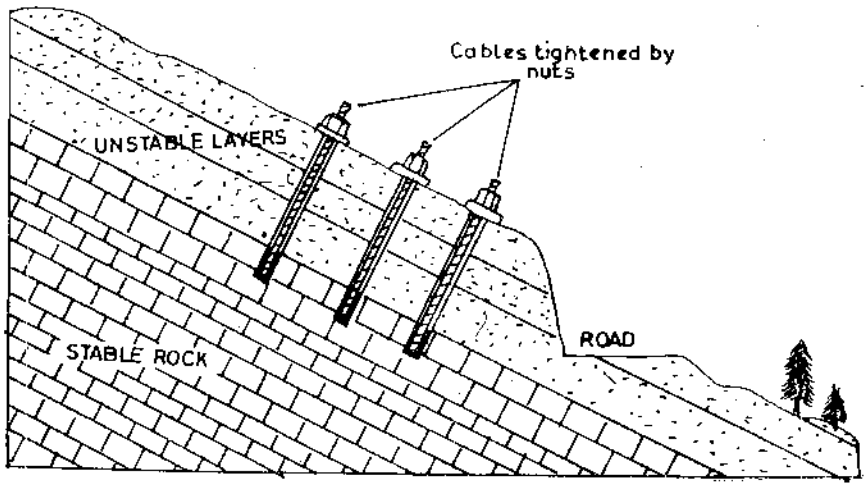

Fig. 7.9. Instalation of rock bolts to stabilize a slope.

Check Your Progress 3 & 4

3. Identify any two of the mass movement types.
4. What are the process involed in controlling landslides.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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7.4. SUBSIDENCE AND SWELLING OF GROUND

7.4.1. Subsidence

Subsidence is defined as the failure of surface materials of the ground in a vertically downward direction. It may vary from a few centimetres to many metres and may be due to either by natural or by artificial causes.

Natural causes : i) Solution of subsurface Rocks : Groundwater is an active solvent for many rocks. When such chemically susceptible rocks support the ground in any given region, there is a possibility of dissolution of these rocks with the passage of time. This may eventually result in subsidence of the ground from above.

ii) Geological constitution : Some times the geological constitution of the region may be responsible for settling of the ground . Thus for instance, when the beds beneath the ground are most flat and of weak in character, like that of shale and peat. There

may result some settling due to the load of the overlying materials which compacts these weak materials.

Artificial Causes : i) Removal of the material : It is a matter of common knowledge that the subsidence of the ground is more common in mining and oil regions. It is because of the extraction of the economically important minerals (solid & liquid) which leads to the development of caving conditions. Subsidence may occur due to removal of coal, metallic ores and oil, with removal of ground water has also been observed in many cases.

ii) Over loading of the surface : In highway construction work, especially in regions where the ground is underlain by soft and moist clay or sand layer or peat deposits. Settling of embankment may occur because of weak nature of the supporting material. This embankment settling is often accompanied by the rise of the ground on either side of the embankment.

7.4.2. Swelling of Ground Surface

Certain clays such as montimorillonite absorb water rapidly and expand consequently. The pressure of this kind of clay within these soil causes swelling of the ground and resultant damage to structures, houses, bridges, dams etc. Percolation of water from cesspools, sanitory tanks, swimming pools and ponds cause swelling of ground surface. The Deccan and Malwa plateaus, consisting of basic lavas and volcanic ash have swelling problems.

Controls : Ground subsidence can be prevented or minimised by sand storing i.e. filling the under ground mines with sand, unwanted debris. Leaving pillars of ores to support the roof beds controls the subsidence or collapse in mines. Water depletion caused by excessive withdrawal can be countered by resorting to artificial recharge of groundwater.

To control the problem of swelling of clays, the soil replaced by another suitable material or it is irrigated to saturation point before construction starts. Chemical treatment to convert expansive clays into non-swelling types involve injection of lime, fly-ash, phosphate and other organic components.

Check Your Progress 5 & 6

5. What are the natural causes for land subsidence.
6. What are the artificial causes for land subsidence.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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7.5. SNOWY MOUNTAINS

Great masses of snow and ice called avalanches move with savage velocity varying from 30 to 300 kms. in the snowy realm. They are triggered as a result of thermodynamic changes following variation in physical conditions such as temperature of air, velocity of wind, and gradient of the slope on where the snow accumulates. The steeper the slope, the greater will be the mass movements. The maximum amount of snow accumulates on slopes between 30^0 to 45^0 .

7.5 .1. Snow Prone areas in India

In the Himalayan slopes avalanches are very frequently observed. In March 1979 about 237 people were killed in a day by avalanches that ravages large areas in Spiti, Lahaul valleys of Himachal Pradesh. During the winter in 1982-83, avalanches took a toll of over 100 people in Jammu-Kashmir alone. The holy shrine of Hemkund, Badrinath, Kedarnath, Gongotri and Yamunotri in Garhwal Himalaya, Trilokinath in Himachal Pradesh and Amarnath in Kashmir continue to be threatened by avalanches in winter.

7.5.2. Types of Avalanches

Three types of avalanches are recognised in the Himalayan slopes. These are loose - snow avalanches, slab avalanches and airborned power avalanches. These three types can be put into two categories - viz., storm induced avalanches and delayed action avalanches.

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The loose snow avalanches consist of loose crystals of snow admixed with air, the loose agggregate set in motion by snow storms. The pillowy, powdery mass(>100 million m^3) of dry snow slip down the steep slope, gathering speed (upto 300 km/h) developing very strong pressure and creating shock waves in the atmosphere of the valley below.

In some situations the snow may continue to pile up. As result, the lower layers get hardend due to load shocks generated by earthquakes explosion or movements of vehicles, lead to failure of the ice layers. The dismembered layers of ice break down into slabs and blocks along fractures as they slip and slip down in the form of slab avalanches (Fig. 7.10).

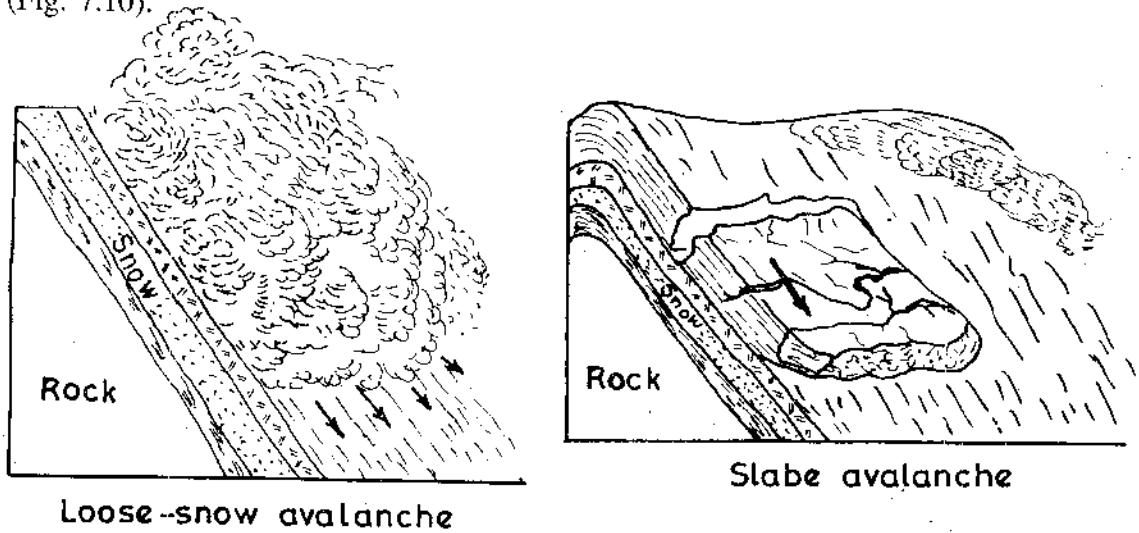

Fig. 7.10. (a) Loose-snow avalanche (b) Slabe avalanche

7.5.3. Avalanche Preventing Structures

In the upper part of the slopes where avalanches commonly develope or triggered, structures normal to the slope direction are to be construced. The retaining structure in the upper part of the slope prevent build up of stress in snow mass thus prevent avalanche occurrance. Below that the snow drift controls structures include snow bridges or snow rakes of timber or alumunium, or steel tubes and pre-stressed concrete, or snow wets of wire or nylon ropes (Fig.7.11) . They help in changing the wind flow characteristics and in preventing concentrated accumulation of snow on vulnerable slopes. Avalanche ramps allow passage over installations and buildings. Avalanche wedges deflect the snow,break the speed of discenting mass of snow and ice and thus provide protection to buildings and installations.

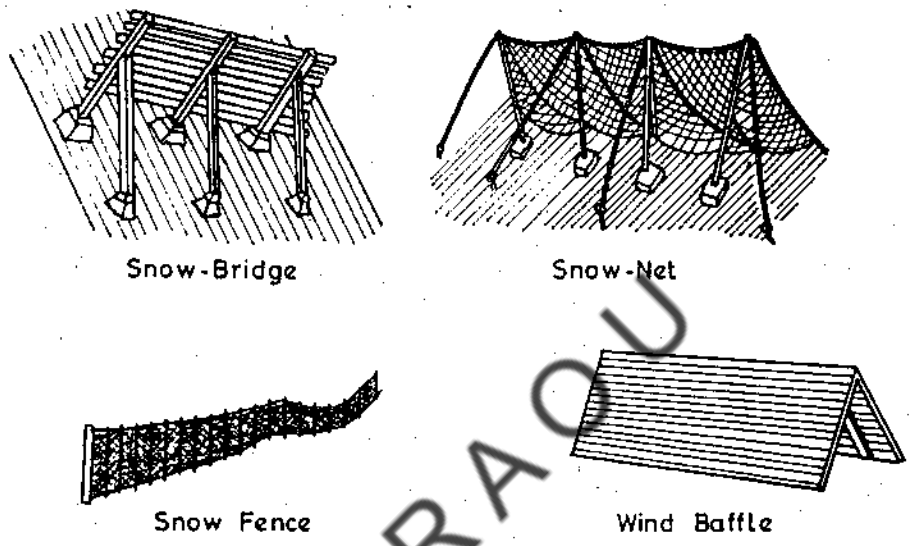

Fig. 7.11. Avalanche - Preventing Structures

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7.6. SUMMARY

Landslides, subsidence, avalanching are part of environmental distrubances. Generally these will occur along the mountain regions. This type of events are causing damge to nature and mankind. Large scale loss of life is not known recently, but historical records shows such incidents.

Hill slopes are the prim areas of landslides . The downward pull of geological materials along the hill slopes is called mass movement. Landslides are mainly due to rapid mass movement. The mountain regions of Nilagiries and Himalayas are the most active areas for landslides. The six important factors for landslides are the 1) Effect of slope 2) Effect of rock types 3) Role of earthquakes 4) Role of water 5) Role of climate and vegetation and 6) Human activity. Landslides are classified as creeps, mud flows, slide falls etc. Identification of landslide prone areas can be made by observing the structural and lithological setting , instaility of slopes, siesmicity of the area, presence of cracks on the ground, falling of trees etc. Landslides can be controlled by drainage control, retention structures. slope reduction, aforestation etc. The choise of these methods may depends on the factors responsible for landslides.

Subsidence is the failure of surface materials of the ground in vertically downward direction. This may be due to natural process or artificial causes. Groundwater and

geological materals plays vital role in natural process. Removal of material and over loading are the two prime factors for artificial causes of subsidence. Ground subsidence can be prevented by filling the underground with sand, leaving ore pillars in mines and artificial recharge of groundwater.

Swelling is another problem in clay zones. Clay absorbs water rapidly and expands causing swelling and damage to structures. To control swelling clay may be replaced with other types of soils or chemical treatment of clay. Great masses of snow moves then it is called avalanching. This snow movement will occur due to temperature variance, wind velocity and steeper slopes. Three types of avalanches are identified in Himalayas, viz., loose - snow avalanches, slab avalanches, and air - borne powder avalanches. Construction of structures normal to the slope direction in the upper parts of slopes can control avalanches.

7.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. In India the mountain regions of Himalaya and Nelagiries are the the two landslide prone areas.
2. The causes of mass movement are 1) The effect of slope 2) Type of earth material 3) Climate and vegetation 4) water 5) Earthquakes and 6) Human activity.
3. The mass movement types are creep or soil creep, earth and mud flows, slump and slides and rock falls.
4. The processes involved in the control of landslides are drianage control, Retention structures, slope reduction, aforestration and slope stability measures.
5. The natural causes of land subsidence are solution of sub-surface rocks and geological constitution of material.
6. The artifical causes of land subsidence are the removal of material and the over loading of surface.

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7.8. MODEL EXAMINATION QUESTIONS

I Answer the following questions in about 30 lines each

1. Explain in detail the controls of Landslides.
2. Define the causes and their controls of the land susidence.
3. Describe the factors influencing the slope stability.

II Answer the following questions in about 10 lines each

1. Evaluate the role of water in mass movement.
2. Explain in general how the landslides occur.
3. What are the slope stabilization measures.

Prof. P.T. Naidu

UNIT-8: FLOODS, CYCLONES AND DROUGHTS

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8.1. OBJECTIVES

After studying this unit, you should be able to:

* explain the causes , types and controlling measures of floods,
* describes the genesis and management of cyclones,
* define the droughts and its causes and controlling processes.

8.2. INTRODUCTION

The natural calamities such as floods, cyclones, and droughts are causing enormous damage to environmental systems. Every year thousands of people and lakhs of cattle are getting effected with these processes. These events can not be prevented from occuring but their impact can be reduced, if effecitve measures are taken to reduce their severity, frequency and possible size. The planning for this disaster preparedness based on appraisal of the magnitude of risks in the past and those anticipated in future can reduce or minimise the damage. Due to geographic reasons cyclones, floods, drught are occuring in some regions regularly. The environmental calamities with flooods, cyclones and droughts are discussed in this unit.

8.3. FLOODS

Rivers are the basic transportation systems that carry rocks and soil materials by the tributaries. Much of the sediment transported in rivers is periodically stored by deposition in the channel and on the adjacent flood plain. Lateral miration of bends of rivers and over-bank flow combine to produce the flood plain. This natural process of over-bank flow is termed FLOODING . The term flood stage frequently connotes that the elevation of water surface has reached a high water condition likely to cause damage to personal property on the flood plain (Fig. 8.1)

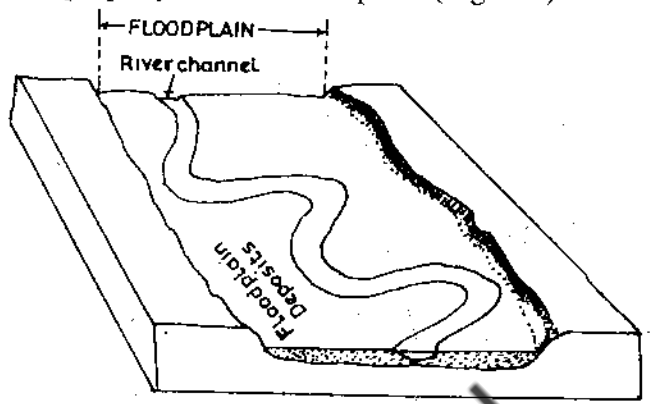

Fig. 8.1. Block diagram showing floodplain and riverchannel

The vast majority of stream floods are linked to precipitation (rain or snow). When rainfall or snow melts some of the water infiltrates or sinks into the ground. Some evaporates directly into the atmosphere. The rest of the water becomes surface run off, flowing down hill over the surface under the influence of gravity into a lake, ocean or stream.

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8.3.1. The Indian Scene

About 40 miles of canal in India is prone to floods and 8.3 miles annually ravaged by inundation. The aerial extent of flooding and the magnitude of damage have been phenomenally increasing in the last three decades. Floods have so far killed more than 18,000 people, and the annual death toll has increased from 942 in 1943 to 2574 in 1981. The Indo-Gangetic plains, supporting 40% of the country's population suffer maximum damage 60% of(15 m/h) cultivated canal becomes inundated inspite of 12, 265 kms of embankments (Table 8.1).

Table 8.1. Flood Hazards in India in selected years

Year	Affected and (m.ha)	Cultivated land (m.ha)	Population affected (million)	Cattle cost (Thousand)	Value of damage (m.Rs.)
1960	7.63	2.65	0.868	14	674
1970	8.45	4.85	2.224	19	2,868
1978	18.61	9.96	7.045	39	14,547
1980	11.42	5.55	5.409	59	8,300

One of the reasons for this phenomenal damage is the fact that factories and housing colonies and settlements continue to be located in land subject to floods that is in the flood-ways. The constrains of landuse thus have a direct bearing on increased flood hazards.

8.3.2. Factors Governing Floods

The rate of surface runoff is influenced by the extent of infiltration, which inturn, is controlled by the soil type. Soils, like rocks, vary in porosity and permeability. A very porous and permeable soil allows a great deal of water to sink in relatively fast. If the soil is less permeable or impermeable, the proportion of water that runoff over the surface increases.

Topography also influences the extent or rate of surface runoff. The steeper the terrain, the more readily water runoff over the surface, and the less it tends to sink into the soil. Water that infiltrates the soil, like surface runoff, tends to flow down fall and may, in time, also reach the stream.

Vegetation may reduce flood hazards in several ways. The plants may simply provide a physical barrier to surface runoff. Also plant roots penetrating into the soil will loosing it, which tends to maintain or increase the soil permeability. Thus reducing the portion of surface runoff. Plants also absorb water. All these factors reduce the volume of water introduced directly into a steam system.

8.3.3. Types of Floods

The discharge volume of an individual stream is often highly variable from month to month and year to year. A sudden unexpected torrent of muddy and turbulent water rusting down a canyon is known as **flash-flood**. A flood can take plaee in a single tributary while the rest of the drainage basin remains dry.

Up stream floods are in the upper parts of drainage areas and are generally produced by intense rainfall of short duration over a relatively small area. **Down stream floods** on the other hand cover a wide area and are produced by the stream of long duration, that saturate the soil and produce increased runoff.

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8.3.4. Causes of Floods

Two factors are critically responsible for the occurance of floods a) the flow of excess water resulting from increased runoff in the catchment area, and b) reduction in the carrying capacity of the channels as a consequencc of accumulation of scdiments or the obstructions built on flood ways.

Excess flows : There can be several causes of excess flow, heavy rainfall and cloud burst, the melting of snows on large scale with attendant bursting of dams built of ice blocks, sudden and excess release of impounded water behind dams, and bursting of man-made or landslide built dams. Excessive rain within a short period is called a **cloudburst**. Cloudbursts are very common in the Himalayas, Orrissa and central and western India. In 1979 within a span of one day, there was 37 to 50 cm. rainfall in Gujarath. The bursting of dams causes catosptropic floods; such as Machu Dam in Gujarath which destroyed the whole township of Mori on August, 1979.

Rise in the sea level in the coastal belts following tidal waves or hurricanes may bring about devastating floods. Cyclones also bring heavy down pours for prolonged periods as happened in two days in November 1982 and then in Junc 1983 in Gujarath, resulting in overflowing of 27 dams.

Reduced carrying capacity of Rivers The capacity of channels conveying water is diminished by the accumilation of sediments derived from severe erosion in the catchment, formation of cones and fans of landslide debris. It is well known that the carrying capacity of a river is governed by discharge of water with sediment, that it carries. Therefore an excess of water or sediment would easily upset the balance, resulting in sprilling over the banks . The extensive flooding in eastern U.P and northern Bihar, especially by the Narayani and Kosi rivers is due to thc reduced carrying capacity of the rivers choked with sediments derived from accelerated erosion in the Himalayan region, and inadequency of slope in the floods plains.

Hazards and control

Hazards effects are primary, due to the floods, secondary, caused by disruptiuon and malfuncion of services and systems associated with floods. Primary effects includes injury and loss of life and damage caused by swift currents, debris and sediment to farms, homes, buildings, rail roads, roads and communication systems. Erosion and deposition of sediment in thc rural and urban landscape may also involve a loss of considerable soil and vegetation. Secondary effects may include short-term pollution of rivers, hunger and disease and displacement of persons who have lost their homes. In addition, fires may be caused by short circuits.

Control a) Restructive zoning & Flood proofing. Various approaches can reduce the rise of flood damage, the first step is to identify the area of risk. Careful mapping coupled with accurate stream discharge data should allow identification of those areas threatened by floods. Land that could be inundated often by floods, perhaps might be restricted to landuses.

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b) Retention ponds : Floods hazards along a stream may be greatly reduced by the use of retention ponds (Fig. 8.2). These ponds are large basins that trap some of the surface run off, keeping it from flowing immediately into the stream. Retention ponds are frequently a relatively inexpensive option, provided that ample undeveloped land is available , and have the added advantage of not altering the character of the stream.

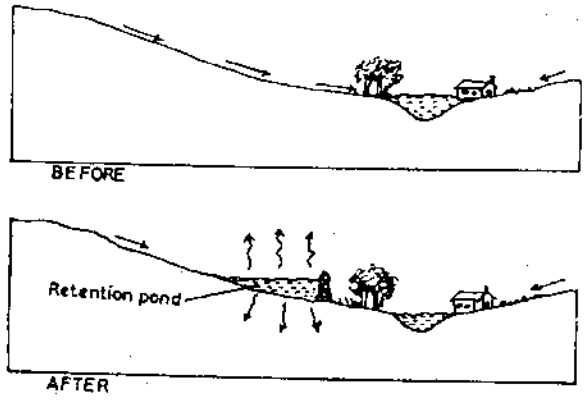

Fig. 8.2. Use of retentionpond to moderate flood hazard.

c) Channelization : Channelization is a general term for various modifications of the stream channel itself that are usually intended to increase the velocity of water flow, the volume of the channels or both. These modifications inturn increase the discharge of the stream and hence, the rate at which surplus water is carried away. The channel can be widened or deepened, especially where soil erosion and subsequent sediment

deposition in the stream have partially filled in the channel. Such measure tends to decrease their flood hazard.

d) Levee : Raised banks along a stream channel. Some streams from low, natural levees along the channel through sediment deposition during floods. These levees may purposely be enlarges with raise the height of the stream bank close to the channel, the water can rise higher without flooding the surrounding country (fig 8.3).

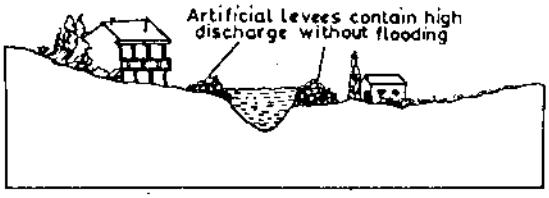

Fig. 8.3. Levees protect floodplain land

e) Flood embankment : Building embankment or bounds parallel to the river banks to prevent spilling of excess water appears to be widely adopted in flood management in India. In the Brahmaputra valley in Assam 2 to 3 metres. high embankments are constructed 1.6 km away from the river edge.

Check Your Progress 1 & 2

1) Identify any two factors governing the floods.

2) Name any two factors responsible for the occurrence of floods.

Note: (a) Space is given below to write your Answer.

(b) Compare your answers with the model answers given at the end of the unit.

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8.4. CYCLONES

The most serious coastal hazards are tropical cyclones, which claim many lives and causes enormous amounts of property damage every year. Tropical cyclones, known as TYPHOONS in most of the pacific oceans and HURRICANES in the western Hemisphere. A tropical cyclone that struck the northern Bay of Bengal in Bangladesh in November of 1970 produced a 6 metre rise in the sea. Flooding Killed nearly 3,00,000 people and destroyed 65% of the total fishing capacity of the coastal region.

In larger cyclonic storms, having diameter of 60 to 160 km. the wind rotates counter clockwise with a speed of more than 200 kms/hour at the periphery while at the centre (eye) remains calm. The highest wind speed recorded in Indian sub continent is 226 km/hr on 15 and 16 October 1947. They move forward with a speed of about 25 km/hr and have a life span of nine days on the average.

Exceptionally heavy rains accompany cyclonic storms 15 to 25cm for even 100 cms locally, in the short duration of the passing of the strom. During the late November 1984 cyclone, as against the normal rainfall of 28.5 cms for the whole of November,

the down pour was 60 cms in just five days and 110 cms in Sullurpet, Gudur and Naidupet areas in Andhra Pradesh.

8.4.1. Genesis

In the tropical belt (5^0-15^0 N) sea water gets heated upto 27^0C or more, so that the over above the water develops low pressure areas. The low pressure area remains stationary for three to four days and draws energy from the sea surface. As the pressure in the centre falls as much as 20 million bars. The wind speed increases to 40 km/hr and cloud burst start spiralling around the center causing squalls. In the center the pressure falls by 3-5 mb. The warmed up air rises as high as 12,000 metres or more, inducing the wind from the surrounding areas to rush inwards creating spirally moving storms. The storms turn at a speed of 100-120 km/hr. anticlockwise in the northern hemisphere but vice-versa in the southern hemisphere. The cyclone then moves landwards to areas of lower pressure.

8.4.2. Hazards on Indian Coasts

The east coast belt embracing Bangladesh, Bengal, Orissa, Andhra and Tamil Nadu is very vulnerable to repeated hazards of heavy down pours that accompany moving fierce winds, mostly in the months of October, November and December, Cyclones are endemic on the Andhra coast, one cutting every second year, The cyclone that struck the coastal belt of India on November, 1970 took 2 lakhs human life and over 8 lakhs heads of livestock, destrying more than 200,000 houses , 80% of the paddy crop, and 65% of the fishing capacity. In the tropical cyclone of November 19-20, 1977 more than 8,5000 people and 30,000 heads of cattle and 2,44,000 goats living on the Andhra coastal belt were killed. It may be noted that cyclonic storms are five times more frequent in Bay of Bengal than in the Arabian sea.

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Table 8.2. Seasonal Frequency of Cyclones in India (1891-1982)

Month	East coast	West coast
January	4	0
February	0	0
March	2	0
April	11	2
May	15	4
June	32	6
July	33	3
August	27	2
September	23	5
October	40	13
November	40	7
December	22	4

(After A.K. Shah et al, 1984)

On an average three to four severe cyclonic storms form in the Bay of Bengal, mostly from April to June in the Pre-monsoon and September to December in the Post monsoon period (Table 8.2). In late November 1984 a cyclone on the Andhra coast

destroyed a little less than one lakh houses and another lakh were partially damaged. A thick cover of sand (as much as 1 metre) rendering barren more than 2000 ha of agricultural farms (Table 8.3).

Table 8.3. Some Severe Cyclones in India

Date	Landfall Point	Maximum Wind speed (Km/hr)	Loss of Life
Nov. 3,1946	Narasapuram(A.P.)	130	750+30,000 Cattle heads
Dec 20-24, 1964	Rameswaram(T.N)	169	500
Dec 4-6, 1972	Cuddalore(T.N)	150	80+141 Cattle heads
Sept. 8-11, 1976	Contore(Bengal)	160	10+40,000 Cattle heads
Nov.14-20,1972	Chirala(A.P.)	259	8547+5, 74,200 Cattle Heads
May, 5-13, 1979	Kilakkarani(T.N.)	222	700+3,00,000 Cattle heads

(After A.K. Saha et al, 1984)

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8.4.3. Identification and Management

In coastal India a 24 km wide belt in the following districts has been identified as a hazard zone by cyclone Review Committee :

Tamil Nadu	-	Chengalpet, Tanjavur.
Andhra Pradesh	-	East Godavari, Krishna, Nellore, Prakasam
Orissa	-	Balasore, Cuttack, Ganjam & Puri
Bengal	-	Midnapur, 24 - Pargana
Gujarat	-	Janagadh, Amreli, Bhavnager

By observing the rotation of major cloud patterns over 24 hours by polar orbiting satellites it is possible to visualize the deflections of cyclone tracks. Through the geosynchronous INSAT-IB satellite, cyclones can be continually monitored and their behavioural pattern determined. The most efficient and effective methods of fore-casting cyclone tracks is using the technique of radar to track them continually. The S-band radar has been formed to be most useful in watching the tracking cyclones.

Advance warning of the impending disaster or hazard allows people to evacuate the threatened areas and reach safer places. In Andhra Pradesh, fisherman have made significant adaptaions in their huts to copeup with high winds. Their huts are made around in plan and the thatched roofs are steeply pitched. The anticyclone features in a hut also include a central anchor post, metal corner straps to fix frame members to corner posts and beams. These huts are built on raised mounds (platforms) of mud

as a safety measure against flooding. Rounded or polygonal shapes of houses, which cause reduction of wind pressure, are most suitable buildings which are built on raised floors need to be an anchored at the corners to the ground through galvanised steel.

Settlements must be quite far from the coast, and located behind natural wind breaks, and developing a massive wall of multistoried forests of tall and deep-rooted trees all along the coastal in the cyclone prone belt.

Check Your Progress 3 & 4

3) What is Cyclone and how it is forming.

4) Which districts in Andhra Pradesh are identified as cyclone prone areas.

Note: (a) Space is given below to write your Answer.

(b) Compare your answers with the model answers given at the end of the unit.

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8.5. DROUGHTS

The lack of sufficiency of rain for an extended period causes a considerable hydrologic imbalance, consequently water shortage, crop damage, stream flow reduction, and depletion of groundwater and soil moisture are observed. It occurs when evaporation and transpiration exceed precipitation for a considerable period. Drought is the most serious physical hazard to agriculture in nearly every part of the world.

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8.5.1. Types

There are four basic kinds of droughts

i) **Permanent drought**, characterizes the climates ; the sparse vegetation is adopted to acidity, and agriculture is impossible without continuous irrigation.

ii) **Seasonal drought**, occurs in climates that have well defined annual rainy and dry seasons, for successful agriculture, planting must be adjusted so that the crops develop during the rainy season.

iii) **Unpredictable drought** involves failure of rainfall and it may occur anywhere, but is most characteristic of humid and sub-humid climates often affects relatively small area.

iv) **Invisible drought** can be recognised in summer, when high temperatures induce high rates of evaporation and transpiration, the result is a borderline water deficiency that diminishes crop yields.

8.5.2. Indian Scene

About 260 m.ha or 79% of the total geographic area of India is subject to different degrees of drought, 20 million hactars falling victim to disasters droughts, 117 m.ha

experiencing severe drought, 76 m.ha having moderate drought and 47 m.ha subject to milder drought. One third of the country encompassing 76 districts has been identified as drought prone.

The 1967-71 drought in Rajasthan brought total damage to the land and the vegetation. The years 1895-1905 and 1962-71 were periods of extremely severe conditions and pronounced drought. Even in the normal years between 1875 and 1970 the total rain fall during the south-west monsoon was 28% less than the normal. One year in every five years faced drought. Some parts of Gujarat, Andhra Pradesh and Tamil Nadu also experienced drought conditions at intervals of two to three years.

Since two thirds of the country's crops, including 42% food grains and industrial raw materials like cotton and groundnut depend on rains. The Indian economy is profoundly affected by droughts in 1979 -80. The production of food grains, pulses and oilseeds fell by 28 million tons.

8.5.3. Causes of Drought

Apart from the obvious statement that drought results from lack of precipitation, it is known that drought is intensified by high temperature, strong wind and low humidity, all of which increase the loss of moisture by evapotranspiration.

One important cause of drought is shifting of normal cyclone tracks across a region, leaving some areas in the region without their normal precipitation for prolonged periods. This is the cause of the perpetual droughts in the great deserts of the earth.

Another recognisable cause of drought is abnormally low seasurface temperature. Low sea-temperature of the coast stabilize the atmosphere so that the vertical air currents needed to produce appreciable precipitation are suppressed. Any region situated down wind from the ocean is likely to suffer from below normal precipitation, if the ocean temperatures are below normal.

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8.5.4. Controlling measures of Drought

Lacking sufficient knowledge of the causes of drought and the ability to predict them, man is in no position to devise effective means of control. Although it is possible in certain circumstances to increase normal parcipitation by seeding clouds with material bunch as dry ice and silver lodide, this method is useless unless rain-bearing clouds are present.

The greatest effect with drought is to agriculture. Irrigation and milching commonly practiced in the agriculture of semi dried climates, may be adopted as emergency measures during drought in more humid climates.

Plants and trees in semi dried climates have become adopted to survival during the dry season of the year. In general, those plants are having protective coating on the leaves to reduce transpiration. Desert plants have deep roots and a minimum of transpiration. Since drought is a complex phenomenon, involving not only rainfall but also ground moisture and other factors, there is no certainty of the occurrence and severity of drought.

8.6. SUMMARY

Floods, cyclones, and droughts are causing large scale damage to environmental systems. Every year thousands of people and lakhs of cattle are getting effected by these processes. Due to geographic reasons cyclones, floods, drought are occuring in some regions regularly.

The overbank flow of rivers is termed floods. The term flood stage is the elevation of water surface to cause damage to personal property of flood plain. Floods are linked to rain fall or snow melting. About 40 miles of different canals in India are prone to flood. Human settlements were established along the flood plains due to richness of soils. Flash floods, upstream floods, down stream floods are the three main types of floods. The causes for floods are a) Excess flows and b) reduced carrying capacity. Floods can be controlled and damage can be minimised by flood proffing, Retention ponds, channelisation, Levees and Flood embankments.

Cyclones are causing large damage along the coastal regions. A tropical cyclone called typhoons are frequent along the east coast of India. Cyclones can be monitored with advance satellite systems and their behavior pattern can be identified. Advance warning about cyclones will allow people to evacuate the threatened areas. To avoid damage from cyclones, settlements must be quite far from the coast and located behind natural wind breaks and development of toll and deep rooted vegetation along the coastal areas in cyclone prone belts.

The lack of sufficient rain fall results drought, which is the most serious hazard to agriculture through out the world. There are four types of droughts namely permenant droughts, seasonal droughts, unpredictable droughts and invisible droughts. In India one third of the area is experiencing drought every year. Low rainfall, high temperature, strong wind, low humidity and less vegetation cause drought. Since drought is a complex phenomenon, there is no certainity of the occurance and severity.

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8.7. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Factors governing the floods : Run off, soil type, topography and vegetation.
2. Factors responsible for the occurence of the floods are : (a) Excess flow of water (b) Reduction in the carrying capacity of the channels (c) Accumilation of sediments.
3. Cyclone is nothing but a tropical storm, when the sea water gets heated upto 27C or more, the air above the water develops low pressure areas. As the pressure in the centre falls, the wind speed increases and creating spirally moving storms. These storms moves to areas of low pressure as cyclones.
4. East Godavari, Krishna, Prakasam and Nellore destricts of Andhra Pradesh are identified as cyclone prone areas by cyclones review commette.

8.8. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Describe the causes & controls of floods.

2. What are the factors governing the floods.

3. Describe the cyclonic Hazards on Indian coasts. Descuss how these can be managed.

4. How many types of droughts are present, and describe them with reference to Indiain Scene.

II. Answer the following question in about 10 lines each.

1. How do upstream and down stream floods differ.

2. Channalization may reduce the local flood hazards - How .

3. What are the causes of drought.

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BLOCK - 3
RESOURCES

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UNIT-9: ENVIRONMENT -RESOURCES

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9.1. OBJECTIVES

After studying this unit, you should be able to :

* explain the origin, distribution and uses of fossil fuels - Coal, Lignite, Petroleum, and nuclear fuels,
* describe how groundwater occurs in the sediments and rocks,
* identify the different types of aquifers and yields of different geological formations.

9.2. INTRODUCTION

In this unit you will study the importance of natural resources in environmental sciences. It includes discussion on minerals like coal, petroleum and gas, uranium and water.

Geo-environment is endowed with rich natural resources like mineral resources and water resources. Minerals are formed in the earth crust at different depths under varied pressure and temperature conditions. Water resources confine to the surface of the earth and down to a few hundred metres in the pores of the rocks.

Minerals are divided into metallic and non-metallic minerals. Metallic minerals are related to iron, manganese, copper, zinc, lead, gold etc. Non-metallic minerals correspond to sulphur, phosphate, limestone and fossil fuels like coal. Most of the metallic minerals are formed under high pressure and temperature conditions by the igneous and metamorphic processes. Most of the non-metallic minerals are formed in the sedimentary processes. Bauxite which is aluminium ore is one of the few mineral deposits formed under atmospheric conditions due to weathering of aluminium bearing rocks.

India is bestowed with huge reserves of certain mineral deposits like iron ores and bauxite. The country is self sufficient in 35 minerals related to the industries of iron, aluminium, cement, glass and ceramics, paints etc. The minerals which are deficient in India and dependent on imports are cryolite, sulphur, boron, petroleum, industrial diamond etc. Production of important minerals in India and their place with reference to world are shown in table-9.1. Values of various minerals produced in India and the share of each state in the national context are shown in fig.9.1.

Table-9.1. Production of Principal Minerals in India and Position in World Production

Mineral	Production in 1980 (tonnes)	% Contribution to World Production	India's Ranking among World Producers
Mica	12,215	73.7	1
Kyanite-sillimanite	64,000	18.5	2
Barytes	4,42,000	5.9	5
Mn-ores	16,92,000	6.3	6
Talc-steatite pyrophyllite	3,84,000	5.6	6
Iron ores	4,19,36,000	4.2	8
Chromite	3,21,000	3.3	8
Magnesite	3,80,000	3.5	9
Coal and lignite	10,90,00,000	3.7	10
Bauxite	17,85,000	20.0	11
Rock-phosphate	5,23,000	0.4	17
Petroleum (crude)	94,00,000	0.3	26

(Indian Minerals Year Book, 1980, I.B.M., Nagpur, 1983, in K.S. Valdiya, 1987.)

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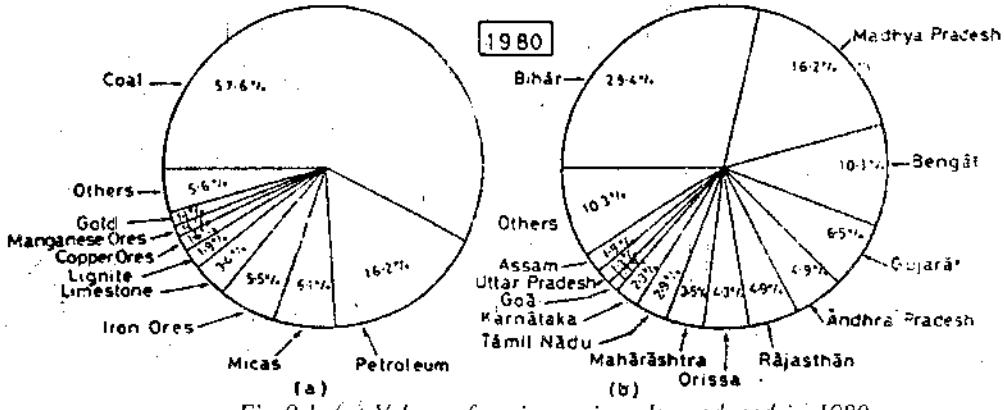

Fig 9.1. (a) Values of various minerals produced in 1980.
(b) Shares of different states in the total value of minerals produced in 1980.
(Data from Minerals Year Book, 1980, Indian Bureau of Mines, Nagpur, 1983)

9.3. FOSSIL FUELS - COAL

Coal and Oil are called fossil fuels as they are the remnants of buried organic materials like plants and marine organisms. These organic species underwent limited oxidation at great depths in the sedimentary basins. Coal is a solid state mineral while crude oil is a fluid.

9.3.1. Origin

Coal is formed from the decay of plants grown in undisturbed lakes, in estuaries, river beds, deltas and in marshy areas and subsequently buried under thick pile of sediments in the geological past. The process of transformation of plant debris to Coal takes place through biochemical action by partial oxidation. It is then protected from further oxidation and preserved. Later, dynamochemical processes act on it for further change in the grade of the Coal. The type of Coal depends on the geo-environment, nature of plant species, and the nature and duration of bacterial action. Generally, Coal is stratified i.e. it occurs in different layers called coal seams which are separated by sediment layers like shale or sandstone.

9.3.2. Chemistry

In addition to carbon and hydrogen, Coal contains sulphur, oxygen, nitrogen and non combustible matter which include silt, clay, silica and other substances. The grade of coal depends on the percentage of combustible matter. Other properties of classification of coal are percentage of volatiles, calorific value (fixed carbon) and moisture. The characteristic feature of coal is fuel ration which is the ratio of fixed carbon to volatile matter. Sulphur is a harmful impurity in coal. If it is more than 1.5%, it disqualifies coal for making gas of coke. Environmental safety limits is at less than 1%. High iron content in the coal gives rise to clinkers.

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9.3.3. Grades

Coal is graded as sub bituminous, bituminous, semi-anthracite and anthracite. Peat is the first state of development of coal which contains the least combustible matter at less than 10%. It is a compact fibrous matter, dark brown or black in colour containing traces of the original plant material. Peat beds are generally thin with only a few centimetres thickness. The highest grade of anthracite may contain sometimes 100% of combustible matter. Fuel ratio is high in anthracite and less in Peat.

9.3.4. Occurrence

Coal formed in India during two geological Eras - Lower Gondwana period (180-275 million years) and Tertiary (1-60 million years). Gondwana Coal fields are situated in the major river valleys like the Godavary (Maharastra and Andhra Pradesh), the Damodar (W. Bengal and Bihar) and the Mahanadi (Orissa). Tertiary Coal fields are situated in Assam & Tamil Nadu. Major Coal reserves are in Bihar followed by West Bengal, Madhya Pradesh, Orissa, Maharashtra and Andhra Pradesh.

In Andhra Pradesh, Coal is mined by the Singareni Colleries Ltd. from the Coal fields at Kothagudem, Tandur and Yellandu in the Godavary Valley. The Coals are non-coking type with low ash content and high moisture content.

Tertiary Coal fields of Assam are of low rank but they have high coking properties with low ash content of 3-4%. Sulphur content, in general, is high from 3-6%. (Coke is a practical name of cake obtained by heating powdered coal in closed crucible. It contains a concentrate of fixed carbon and ash. Volatile matter is driven off due to heating). Peat beds are reported in parts of Tamil Nadu, in Kashmir and between Calcutta and Point Calimare.

9.3.5. Lignite

Lignite deposits of Neyveli in South Arcot District, TamilNadu are well known for their sole occurence in large reserves in India. It is dark brown in colour with a density of around 1.16. It ranks between peat and bituminous coals. It may be fibrous, amorphous or woody in texture. Neyveli lignite is compact. Moisture content is around 50% and ash content around 3%. Volatile matter and fixed carbon are 25% and 22% respectively. The deposit is at a depth of about 60 meters with about 15 meters thickness and spreads over an area of 250 sq. km. The problem faced in mining of this deposit is abundant quantity of groundwater with high artesian pressure. By heavy pumping of groundwater the pressure is reduced and lignite mining is under progress.

Lignite also occurs in minor quantities in Bikaner District of Rajasthan, Kutch District of Gujarat and also in some parts of Jammu and Kashmir.

9.3.6. Reserves of Coal and Lignite

Reserves of Coal and Lignite deposits in India are given state wise in the table-9.2.

Table-9.2. Reserves of Coal and lignite of different states in India.

State		Gross Reserves x 1000 million tonnes
West Bengal	-	19.3
Bihar	-	35.3
Orissa	-	10.2
Madhya Pradesh	-	17.2
Maharashtra	-	6.7
Andhra Pradesh	-	5.5
Assam, Meghalaya, Nefa	-	0.6
Nagaland	-	0.05
Rajasthan	-	0.02
Gujarat	-	0.17
Kashmir	-	0.05
Tamil Nadu	-	2.0
Total	:	97.0

(Source : Commerce, Annual Number, 1970)

In the total reserves of 97 thousand million tonnes, Metallurgical Coal reserves are around 19 thousand million tonnes which are mainly produced from the Bihar mines. Railways utilise about 30% of the production while iron and steel Industry consume around 20%. The rest of the production goes for thermal power plants and fertilizer

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plants. Minor quantities of coke and briquettes of lignite are exported. With a production of 0.1 thousand million tonnes of coal and lignite per year (as per 1980 figures), India contributes 3.7% of the world production and ranks 10 in the world producers.

Check Your Progress 1 & 2

1. What is a fossil fuel ?
2. How Coal is formed ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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9.4. PETROLEUM AND NATURAL GAS

Petroleum and Natural gas are also the products of remnants of Ancient organisms.

9.4.1. Chemistry

Petroleum literally means rock oil. Like coal, petroleum and natural gas also compose of hydrocarbon. Other chemical mixtures are oxygen, nitrogen and sulphur. Petroleum and gas deposits occur at great depths ranging from less than 500 m to more than 10,000 m. About 65% of world production is from less than 1500 m depth. The properties of hydrocarbons are different for different series of CH. At normal temperatures, some exist as gases, some as liquids and some as solid waxes. The components of crude oil are Benzenes (gasoline), Kerosene, gas oil, lubricants, and residuals. Byproducts of petroleum are PVC, acetic acid, polystyrene, ethyl alcohol, acetone glycols, phenols, epoxy resins, styrene butadiene rubber, butyl rubber, lubricating oil dopes etc. No two oils are same with respect to the proportion of these components. For instance, some crude oils are rich in gasoline while some are rich in other components. Some crude oils may contain high content of sulphur. Oils are referred to as paraffin base, asphalt base and napthene base or mixed base. Generally, paraffin base oils are light and yield good lubricants. Others are pitch black in colour. Asphaltic base oils are heavy, not suited for lubricants and are used only as fuel oil. Odour of petroleum may also vary from petrol like smell to rotten egg smell depending on chemical composition.

9.4.2. Origin

There are two theories for origin of oil and gas. One is inorganic theory of volcanic origin. The second is organic origin. There are accumulating evidences in favour of the latter. Remains of marine organisms, the planktons like diatoms and algae are considered to be the source for oil formation. These organisms buried in marine muds undergo decomposition under anaerobic (without oxygen) conditions to yield hydro-

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carbons. The droplets of oil formed thus are migrated into a favourable reservoir rock with good porosity and permeability like sandstone and accumulated into a pool of oil. Such pools are necessarily capped, trapped and retained by impermeable formation to make it an economical reservoir. Otherwise it will be in a dispersed state over large areas which is not viable for production. Structures like folds and faults in the subsurface formations are favourable sometimes to create reservoirs and provide traps for retention. Anticlinal fold is considered to be the ideal structure for oil accumulation at the crest part. Faults bring impermeable formations in juxtaposition with oil bearing formations and thus help to trap it. Sometimes fault zones have negative effect in the sense that oil may escape along the weak planes. Most of the Petroleum occurrences are in the geological formations of Tertiary age (1-60 million years). Most of the oil producing areas are closely situated to the oceans or seas of the present days.

The highest oil reserves are located in the Middle east countries and north Africa with about 70% of the world's reserves followed by U.S.S.R. and U.S.A.

In the process of convertion of organic matter into petroleum, natural gas is also formed. The gas is dominently methane.

9.4.3. Occurrences in India

Oil was found in India in 1825 in the Brahmaputra Valley in Assam and was first struck in 1890. The well known oil fields in Assam are at Digboi. The recently discovered oil fields are at Nahorkatiya, Moran, Rudrasagar, Lakwa and Guleki. Subsequently in 1960, oil was also found in Gujarat at Ankaleswar. Other oil fields in western India are at kalol, Nawagam and Sanand around Ahmedabad. The recent striking of oil was at Bombay high in 1973 located in the Arabian Sea about 160 km north-west of Bombay.

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Further exploration by the oil and Natural Gas Corporation Ltd. for oil and gas in the west coast and Krishna, Godavary and Cauvery delta regions and their off-shore areas on the east coast are promising with many proved gas and oil occurrences.

9.5. NUCLEAR FUELS - URANIUM

Nuclear energy is used not only for destructive purpose in the form of nuclear bombs, but also for peaceful and medical purposes. Nuclear power plants are gaining importance for generating electricity. Hydroelectric plants which depend on the river waters are facing sevcre setback in the recent years due to vageries of monsoon and silting up of reservoirs. Thermal power plants based on the coal are costlier. Nuclear power plants have become advantageous since the power generation is cheaper. The basic raw material used as fuel in the nuclear power plants is Uranium. By the process called fission, nucleus of Uranium atom is split by bombardment with neutrons and as a result heat energy is generated. It was estimated that from one pound of fissionable material, temperature of some millions of degrees of centigrade is created. The fission of one tonne of Uranium equals the energy of three million tonnes of coal. Nuclear power plants are located in India at Tarapur in Maharashtra, Rana Pratap Sagar in Rajasthan and Kalpakkam near Madras. Nuclear energy would replace coal and oil in future for propelling ships, trains, aeroplanes, rockets etc.

Uranium occurs in its oxide state as U_3O_8 in mineral Uraninite and Pitchblende with a content of 50 to 80% (U_3O_8). In davidite it is 7 to 10% and still low in secondary minerals like carnotite, torbernite, and autonite. Uranium bearing minerals are formed by different geological processes and therefore associated with many rock formations. Uranium exists in two valency states as U^{+4} and U^{+6}. When U^{+4} oxidises to U^{+6}, it is easily soluble. Thus groundwaters or infiltrating surface waters may leach Uranium, transport it to different places and redeposit as rich secondary deposits.

Rich deposits of Uranium are known to occur in Canada, U.S.A. and South Africa. In India the only Uranium mine is at Jaduguda in Singbhum District of Bihar. Here it is associated with copper deposits. The average grade of the ore is 0.05 to 0.1% U_3O_8. The deposit occurs at a depth of about 300m. About 4 million tonnes of ore is estimated at this place.

Other places of occurrence are around Umra and Udaisagar and Khetri in Rajasthan. Recent findings are in Chikmagalur district, Karnataka, Tehri District of U.P. and Bodal in Madhy Pradesh. Latest findings of Uranium occurrence are reported in Cuddapah and Nalgonda Districts of Andhra Pradesh. Experimental methods are under progress to extract uranium by water circulation by putting bore wells in the uranium bearing formations in the north eastern region in Meghalaya state. It is reported that as a byproduct, 7800 tonnes of U_3O_8 can be recovered from the copper tailings in Roam - Rakha, Surda and Mosaboni copper mines and another 1750 tonnes of U_3O_8 can be extracted from phosphate based fertilizer plants.

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Check Your Progress 3 & 4

3. What is the composition of Petroleum ?
4. Name any two uranium minerals ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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9.6. WATER RESOURCES

The mineral resources which are non-renewable resources would improve the economic conditions of a country and the renewable water resources influence on its over all progress.

Water is the second essential requirement for sustanance of life. Water is required not only for the drinking purpose but also for agricultural and industrial growth. The contrast in life styles of people in the water scarcity and water abundant areas is quite evident as one compares different parts of the country. Water occurs on the surface as well as in the subsurface layers of the earth. While the surface fresh water bodies like rivers and lakes contain 0.01%, the subsurface water called groundwater consti-

tutes about 0.6% of the total water resources. Two-thirds of the groundwater occures at more than 750 m depth but economically, it can be exploited upto a depth of 300 m. The total groundwater reserves down to this depth is given as 3.7 billion m^3. But much of this is in the Indo-Gangitic - Brahmaputra region and in the coastal plains which are associated with non-indurated sediments. Rest of the country which is occupied by hard rocks and other consolidated sedimentary rocks has limited reserves. The occurrence of groundwater and its potentiality are described below in detail.

9.6.1. Occurrence of Groundwater

Occurrence of groundwater in an area depends on the nature of geological formations. These formations are basically divided into sedimentary, igneous and metamorphic rocks. Sedimentary formations are further classified as unconsolidated, semi-consolidated and consolidated. Gravel, sand, silt, clay and their admixtures belong to the first category. Shales, sandstones, of limited induration are semi-consolidated which are loosely packed and friable. With higher degree of compaction and cementation, they become indurated and transform into rocks which are compact and hard. Voids or pores exist between grains when they are packed together. This is a property of the formation called 'porosity'. (Fig 9.2) Porosity decreases in the unconsolidated sediments and least in the consolidated sedimentary rocks. Porosity values of different formations are given in table-9.3.

Table-9.3. Representative Values of Porosity and Hydraulic Conductivity (After Morris and Johnson)

Material	Porosity %	Specific Yield %	Hydraulic Conductivity, m/day
Gravel, Coarse	28	23	150
Gravel, Medium	32	24	270
Gravel, fine	34	25	450
Sand, Coarse	39	27	45
Sand, medium	39	28	12
Sand, fine	43	23	2.5
Silt	46	8	0.08
Clay	42	3	0.0002
Sandstone, fine-grained	33	21	0.2
Sandstone, medium-grained	37	27	3.1
Limestone	30	14	0.94
Dolomite	26	—	0.001
Dune Sand	45	38	20
Schist	38	26	0.2
Basalt	17	—	0.01
Gabbro, Weathered	43	—	0.2
Granite, weathered	45	—	1.4

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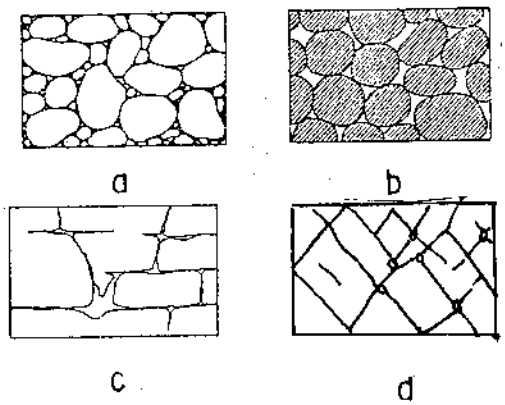

Fig. (9.2) Examples of rock interstices and the relation of rock texture to porosity.
(a) Well-sorted sedimetary deposit having high porosity.
(B) Poorly sorted sedimetary deposit having low porosity.
(C) Rock rendered porous by solution
(D) Rock rendered porous by fracturing (after Meinzer)

Bedding plane is a weak plane and a kind of porosity in the consolidated rocks. Limestones sometimes develop cavities due to dissolution by acidic waters. Groundwater occurs in these pores. Igneous rocks are those which crystallise form magma at greater depths. They are exposed on the ground surface due to certain geological processes. Granite, grabbro are some examples of this rock. These rocks are originally massive, hard and compact and devoid of pores. But some processes called weathering, solution action and tectonic disturbances (movements in the earth crust) create secondary porosity in these rocks. Weathering process decomposes and disintegrates a rock converting it into clayey substance. Thus intergranular porosity is developed in it. Folding and faulting of rocks in the geological past developed joints and fractures in the rocks. This is called fracture porosity. Igneous rocks thus become water bearing. Volcanic rocks like basalts of Deccan Traps contain cooling cracks and columnar jointing. Some kinds of basalts develop vesicles. Weathered zone is also present at the surface. Thus basalts are water bearing.

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Metamorphic rocks are formed when the sedimentary and igneous rocks are subjected to heat and pressure. There by those formations undergo change in their original texture and structure and assume new form. Depending on the nature of rock, they are called schist, gneiss and granulite. Granite gneiss, charnockite, khondalite, mica schist, slate etc belong to this category. These rocks also develop secondary porosity similar to igneous rocks. In addition, foliation in some rocks is a weak plane which allows water to enter.

9.6.2. Hydrological Properties

Porosity is defined as the volume of void space per unit volume of the rock expressed in percentage or simply as fraction. It represents the capacity of the rock to hold water. But the entire water cannot be taken out as certain amount is always held up by the grain surfaces due to molecular forces and also due to capillary forces within the voids. The fraction of water retained in the pores against gravity force is called specific retention. This parameter is also represented as a percentage of the unit volume of the rock. The fraction of water that can be drained from the pores by gravity is called specific yield. The some is called as storage coefficient or storativity in case of confined aquifers. Specific yield and specific retention together equals to porosity.

$$p = \frac{100v_p}{V}, \qquad S_r = \frac{100v_r}{V}, \qquad S_y = \frac{100v_y}{V} \text{ and } P = S_r + S_y$$

Where P = Porosity, S_r = Specific retention, S_y = Specific Yield, $_p$ = Volume of pore space, $_r$ = Volume of water retained and $_y$ = Volume of water drained and V = Volume of the rock.

Values of specific yield for different formations are given in table 9.3.

The values in the table reveal that clays, though, possess the maximum porosity, its specific yield is very low. That is why clays yield low quantities of groundwater. Sand and gravel on the other hand, contain maximum specific yield value and therefore they hold and give large quantities of groundwater. In clays, the total grain surface in the pores is very high and hence the molecular forces are also high. Therefore, specific retention factor is very high. Quantification of groundwater resource in a formation is based on the specific yield factor but not on porosity.

Groundwater potentiality of a formation is also decided by its rate of flow. The movement of groundwater in a rock formation depends on the degree of interconnection of pores. The ease of movement of groundwater is indicated by the parameter known as permeability or hydraulic conductivity (K). Hydraulic conductivity is defined as the volume of water that flows through a unit area of cross-section of the aquifer under unit hydraulic gradient in unit time (Units are m/day). The flow through the entire thickness of the aquifer and over a width of 1 m under similar conditions is known as Transmissivity (T) (Units are m^2/day). Transmissivity of an aquifer is therefore can be computed with the simple relation.

$$T = K\ b.$$

Where 'b' is thickness of the aquifer in metres. Representative values of K for different geological formations are given in table-9.3.

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The above figures reveal that hydraulic conductivity is maximum for gravel sediments and minimum for clays. Lowest value for clays is because of the very small size of the pores. Sand and gravel which transmit water with greater ease are called aquifers. Good aquifers are those formations which have high specific yield and high hydraulic conductivity. Sand and gravel, therefore, are considered as potential aquifers which contain large quantities of groundwater and sustain heavy pumping. Clays are porous but not permeable. Therefore they cannot transmit water in appreciable amounts. These formations are called aquicludes. Semipermeable formation like silts or admixed sediments of gravel, sand, silt and clay have limited capacity to transmit water. Such formations are called aquitards. Rock which neither contains nor transmits water is called aquifuse. Hard granite is an example for it.

9.6.3. Vertical Distribution of Water

Rainwater or surface water infiltrates into the soil zone. It first replenishes soil moisture deficiency which is developed during dry period and then saturates the soil zone. Soils have certain capacity to hold water. The maximum capacity which they can hold is called field capacity. Excess water to this limit drains downward by gravity and accumulates above an impermeable rock or formation. The percolating water thus

saturates the rocks below filling all the voids. The upper surface of zone of saturation is called **water table** (Fig. 9.3).

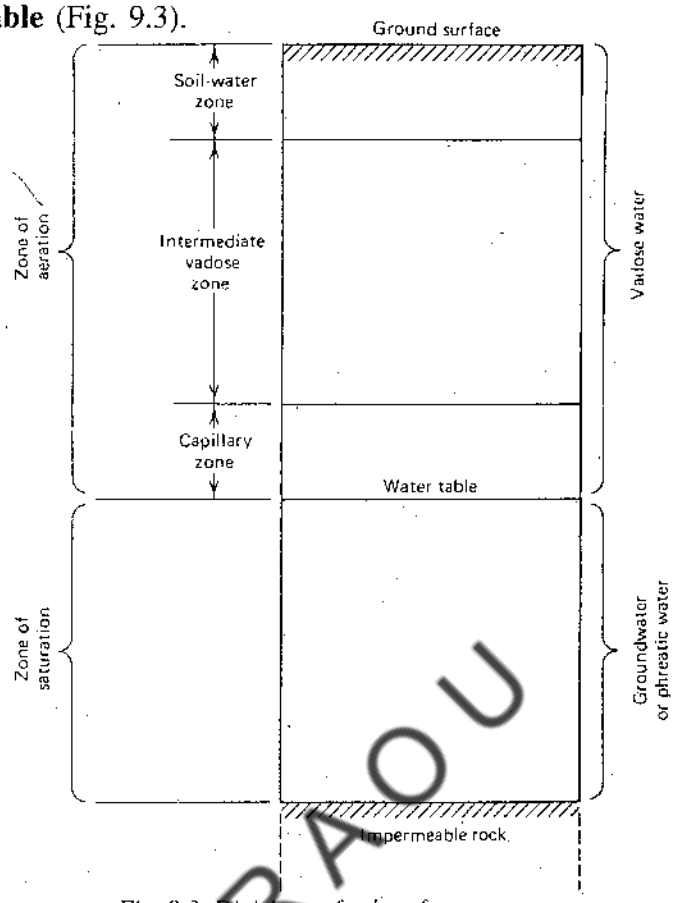

Fig. 9.3. Divisions of subsurface water

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The water below this surface in the zone of saturation, is called **groundwater.** Hydrostatic pressure of the water in this aquifer is equal to the atmospheric pressure. Hence when a well is dug into this zone, water enters freely. The space between ground surface and water table is called **zone of aeration.** The water in this zone is called vadose (shallow) water. The surface zone is soil water zone explained above. Below soil water zone lies the Intermediate vadose zone. In this zone, the voids are partly filled with air and partly filled with water. Water is held in the voids by tension forces at less than atmospheric pressure. That is why these water molecules cannot enter into open pits ended up in this zone. The bottom layer of this zone or the layer immediately above water table is called **capillary zone** which varies in thickness from a few centimetres to a metre or more depending on the grain size (void size). Water raises above water table due to capillary forces. The height increases with decrease in pore size. Therefore capillary zone is maximum in silts and clays and minimum in sand and gravel. Thickness of vadose zone, other wise, depth to water table varies from place to place depending on climatic conditions and topography. In tropical areas with high rainfall, water table is generally shallow within a few meters from ground surface and in arid areas as in deserts, it is very deep with even more than 100m. Topographically, water table is shallow in the plains, valleys or topographically, water table is shallow in the plains, valleys or topographic depressions. In some cases water table is almost at the ground surface in which case the vadose zone is absent. Water table is deeper in the high level plateau areas, mounds, ridges and similar topographic

highs. Along the margins of plateau lands as in Deccan trap areas and on the banks of some gaining rivers, water table tends to be deeper from 20 to 30 m below ground surface during summer season. Seasonal fluctuation of water table is also controlled by these factors. Fluctuation also generally follows the trend of water table depth. In deep water table conditions, fluctuation is high. In the shallow conditions, fluctuation is generally low.

Check Your Progress 5 & 6

5. Where does groundwater occur in Rocks ?
6. Define Water table ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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9.6.4. Types of Aquifers

Aquifers are classified into **unconfined, semiconfined** (leaky artesian) and **confined** (non leaky artesian) depending on the nature of overlying and underlying formations of an aquifer. (Fig. 9.4).

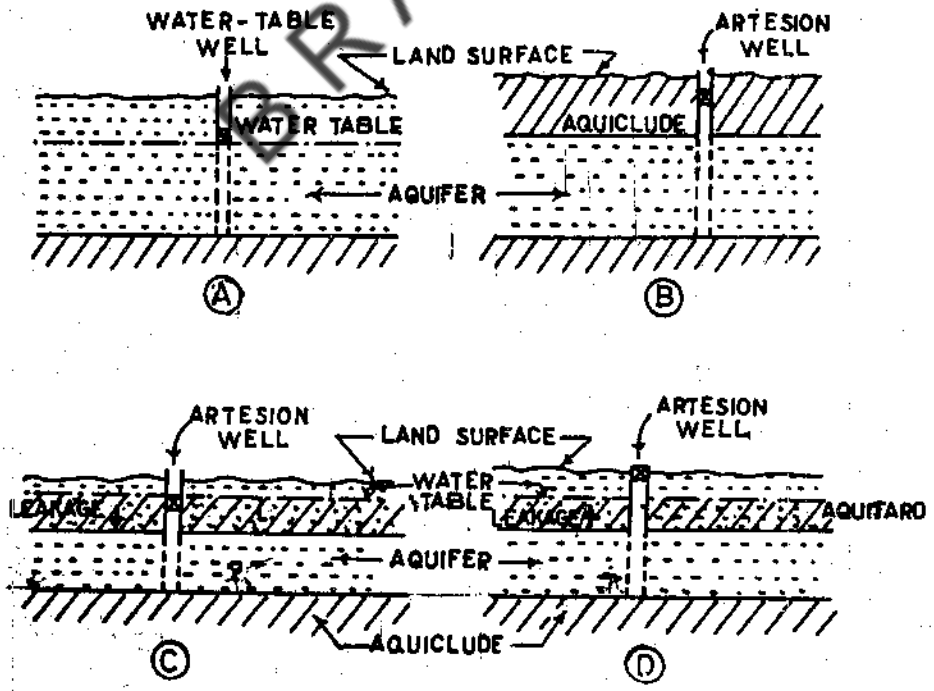

Fig. 9.4. Diagrammatic Examples of Unconfied Aquifer (a) nonleaky artesian aquifer (b) Leaky artesian aquifer with downward leakage (c) and leaky artesian aquifer with upward leakage

Unconfined aquifer is one which is exposed to the atmosphere with out any hindrance. It is also called water table aquifer and phreatic aquifer. Hydrostatic pressure of groundwater is equal to the atmospheric pressure i.e. the water level in the wells

remain at the same level as the water table in the aquifer. Surficial layers of granular beds in flood plain deposits on the river side, valley fill deposits, coastal plains and weathered and shallow fracture zones in the hard rocks are examples of unconfined aquifers.

Confined aquifer is developed when the aquifer bed is overlain and underlain by impermeable beds as clays or shales i.e. aquicludes. The aquifer is exposed to the ground surface only in its outcrop area which becomes recharge area. Hydrostatic pressure in the confined aquifer is higher than the atmospheric pressure. The pressure head in the aquifer depends on the elevation of the recharge area. When such an aquifer is pierced by a tube well, water level raises above top of the aquifer depending on the pressure head. Therefore the imaginary level to which the water raises in such tube wells is called **piezomitric surface**. When the elevation of piezometric surface falls above ground level, it becomes a free flowing well.

When an aquifer is overlain by a semipermeable bed or aquitard such as silts, or admixed sediments which has permeability less than that of the aquifer, a **semi-confined aquifer** is formed. This is also called **leaky aquifer**. Depending on the relative positions of the piezomitric surface of semiconfined aquifer and the water table in the unconfined aquifer above, groundwater leakage takes places downward or upward following hydraulic gradient i.e. from higher head to lower head (fig. 9.4)

Confined and semiconfined aquifers form in the sedimentary basins where more than one kind of lithological formations are situated at different depths. In the hard rocks such as granites, the deep fracture zones also behave like semiconfined or confined aquifers.

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Sometimes aquifers of limited extent exist in the zone of aeration separated from the main aquifer. This is due to presence of lenses of clays within the zone of aeration. Such aquifers are called **perched aquifers**. When such aquifers are opened at the bottom due to deepening of wells for augmentation of yields, the zone of aeration below is exposed and the water in the perched aquifer is lost into the dry zone below. The well becomes dry in such cases.

9.6.5. Groundwater Development

Groundwater is exploited through different well structures depending on the depth of aquifer and its potentiality. Unconfined aquifers which are close to the surface are approachable by shallow structures like **dug wells, driven wells** or **filter point wells.** Driven well is constructed by simply driving a pipe in to the sand or gravel at shallow depth as commonly used for domestic purposes. Filter point wells are constructed for irrigation purpose in the flood plains. Tube wells of less than hundred to a few hundred metres depth are constructed in the confined aquifer system to tap the deep aquifers. A tube well consists of an assembly of alternate blank (with out perforations) and screen (with perforation) pipes. Screen is kept opposite to an aquifer and blank pipe against clay or similar non-productive and collaposing zones. **Bore well** is another common well structure used in the hard rock areas like granitic gneisses, khondalites, basalts, limestones, quartzites etc. A casing pipe is inserted in the soft zone comprising soil zone and weathered zone. The hard rock below is left open. Ground water from the fractures directly enters into the bore hole.

Alluvium aquifers are tapped generally by dug wells, filter point wells or shallow tube wells of less than 30m depth in the flood plains along river courses, and coastal and delta areas. Yields of these aquifers are highly variable depending on the nature of aquifer materials. The yields may range from 30 m^3/hr (one cubic meter equals thousand liters) to more than 100 m^3/hr. Some deep tube wells in the Gangetic plain and in the Terai Plain along the foothills of Himalaya yield upto 600 m^3/hr. Free flow from some tube wells varies from 100 to 300 m^3/hr.

Semiconsolidated to consolidated sedimentary formations like Gondwanas and Tertiary formations are tapped by deep tube wells as in Godavary Valley (Khammam, Karimnagar, Warangal, Adilabad Districts) and in Chintalapudi - Duddukur areas in West Godavary District. Their yields range from about 30 m^3/hr to more 100 m^3/hr. Hard rocks are generally tapped by dug wells and bore wells. Weathered zones are exploited by dug wells with a maximum depth of 15 m. Their Yields are very low with less than 30 to about 100 m^3/day. Fracture zones are usually at depth and are tapped by bore wells upto a maximum depth of 100 m. Yields are highly variable from less than 1.0 m^3/hr to 13 m^3/hr and rarely more than 20 m^3/hr. Failures with nil discharge are not uncommon.

Check Your Progress 7 & 8

7. Which of the following are aquifer, aquiclude, aquitard and aquifuge-clay, sand and clay, sand, granite ?
8. What is a tube well ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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9.7. SUMMARY

Natural resources are the minerals, fuels and water. The process of extraction of this resources, its usage and dumping of waste from such resources is largely effecting the environment. Coal and oils are termed as fossil fuels. Minerals are of two types namely metallic and non-metallic minerals. Water is available as surface water and groundwater.

Coal and oil are the remnants of buried organic matter like plants and marine animals. The process of transformation of plant debris to coal takes place through biochemical action and partial oxidation. Different grades of coal is available in nature. Coal is classified as bituminous, anthracite, lignite and peat. Peat is the lowest grade and anthracite is the highest grade. In India coal occurs mainly along the Godavari, Damodara and Mahanandi Valleys. Tertiary Coal occurs from Assam, lignite occures in Tamilnadu.

Petroleum (Rock oil) and natural gas deposits occurs at great depths. The components of crude oil are gasolene, kerosene, gas oil, lubricants and residuals, Byproducts of

Petroleum are PVC, acetic acid, polystyrene, ethyl alcohol, acetone glycols, phenols, epoxy resins, rubber, lubricating oil etc. Natural gas is methane. Majority scientist believed that oil and gas are organic in origin. In our country oil & gas occurs in Digboi (Assam), Ankaleswar (Gujarat) Bombay high (Arabian sea). Further exploration is doing in Krishna, Godavari and Cauvery deltas. Certain areas in this deltas are identified as promising occurence of oil and gas.

Uranium is a nuclear fuel. This is useful to generate energy and for the preparation of destructive bombs. These fuels may also useful in medical treatment. In India the only Uranium mine is at Joduguda (Bihar).

Water resources are the second essential requirement to life. Water occurs on the surface of earth in the form of rivers, lakes etc. and in the subsurface as groundwater. Occurence of ground water depends on the nature of geological formations. Water bearing formations are called aquifers and these are classified as unconfined, semi confined and confined aquifers. Groundwater development is with open wells from shallow aquifers and with bore wells from deep aquifers.

9.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Fossil fuel is the remnant of organic matter buried in the geological past.
2. Coal is formed due to decay of plants under anaerobic conditions.
3. Carbon and Hydrogen or Hydrocarbon.
4. Primary Uranium minerals are Uraninite and Pitchblende.
5. Groundwater occurs in pores.
6. Water table is the upper surface of zone of saturation.
7. Sand-aquifer, Clay-aquiclude, Sand and clay-aquitard, granite-aquifuse.
8. A tube well is an assembly of blank and screen pipes inserted in sedimentary formations.

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9.9. MODEL EXAMINATION QUESTIONS

I. Answer in 30 lines.

1. Write the origin, Classification and occurrence of Coal in India.
2. Give a detailed account of petroleum and natural gas occurrences in India.
3. Describe the different types of aquifers.

II. Answer in 10 lines.

1. Write in brief about Uranium-its use as nuclear fuel and occurrence in India.
2. Define porosity, specific yield and specific retention.
3. Define hydraulic conductivity, transmissivity and storativity.

Prof. G. Krishna Rao

UNIT-10:EXPLOITATION OF RESOURCES AND ITS IMPACT ON ENVIRONMENT.

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10.6. Check Your Progress : Model Answers
10.7. Model Examination Questions

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10.1. OBJECTIVES

After going through this unit, you should be able to :

* explain the various environmental problems associated with the exploitation of resources,
* describe the environmental problems linked to oil spills and blow outs,
* explain the possible causes of nuclear accidents,
* describe the environmental problems related to the overdraft of groundwater.

10.2. INTRODUCTION

The natural environment is man's most precious heritage. In recent times the concern for its quality was triggered by the backlash effect of accelerated economic growth in the industrialised countries.

Exploitation of resources (Mining) is second only to agriculture as the World's oldest and most important activity. Maximum exploitation of the natural resources was, until recently considered as a desirable objective and the attendent pollution of air, water and land was accepted as unavoidable. The damage done by mining was small in the past and largely repaired with the passage of time. The onset of industrial revolution demands for raw materials for an ever increasing standards of living, culminated in extensive mining. Thus the criteria of impact of mining on the environment and environmental protection in resource exploitation comes into the picture.

Admittedly, it is not possible to stop mining activities for the sake of keeping the environment intact. The crux of the problem is how one can minimise the impact on the ecosystem and still achieve and advance in the industrial development of the Nation.

10.3. INDIAN MINING SCENARIO

India is endowed with a wide range of mineral resources. Mining operations are spread-out all most all parts of the country for extraction of around 65 minerals from more than 4,000 mines. These minerals are being mined by open cast and underground methods. World wide, more than 75% of minerals are extracted by open cast workings. Infact most of the Iron ore, Limestone, Bauxite, Dolomite, Lignite, Chromite and Magnesite production comes from open cast mines. Even for such minerals as Coal, Copper and Lead & Zinc, which are traditionally won from underground mines, the emphasis is gradually shifting towards large scale open cast mining as seen from the development of giant Singrauli coal field, the Malanjkhand copper deposit and Rampur Agucha Lead-Zinc deposits. It is estimated that about 95% of the total output in respect of metallic and about 99% in respect of non-metallic minerals comes from open cast mining sector. With the increase of price level of minerals and technological developments, the deposits with higher stripping ratio may be economically mined, resulting in increasing the areas of open cast mining activities.

At present more than 80,000 hactares of land in India are under the stress of mining activities of various kinds (VALDIYA, 1987). A much larger area is disturbed by other activities associated with mining. The recovery of minerals and construction material requires removal of vegetable cover with underlying soil mantle and excavating overlying rock masses (over burden) which more commonly exceed the volume of material sought. The result is reshaping of the topography, generation of large quantities of debris and disruption of surface and ground water circulation.

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10.4. TYPES OF MINING - IMPACT ON ENVIRONMENT

Depending on the conditions of the terrain and the depth of the ore deposits, two main types of mining operations are being carried out - Open Cast Mining or Quarrying to extract surfacial and shallow deposits, and Underground Mining to recover deeper ores.

10.4.1. Open Cast Mining

In this process two methods are applying.

Contour Strip Mining : In the Open Cast Contour Strip Mining the over burden is stripped away to recover the minerals by use of Bulldozers, Scrapers or by manual operations. In this type of mining removal of over burden, starting from the out crop and proceeding along the hill side so that one cut after another is made and a series of benches formed (Fig. 10.1). In this type of mining, rich soil together with over burden is scraped off and pushed down slope. The sliding of great volume of debris causes great damage to the vegetation and to the springs and streams. Ugly scarification and drastic reshaping of the landscape and serious destruction of forests have occured in the Mussoorie hills over looking the Dehradun Valley as a result of mining of lime stone and dolomite over a stretch of 40 Km. area. Indiscriminate mining of this kind induces landslides and erosion.

Area - Strip Mining : In the relatively flat terrain, area - strip mining involves cutting of trenches (Fig. 10.1) has resulted in extensive deforestation, destruction of top soil, lowering of water table and pollution of surface water.

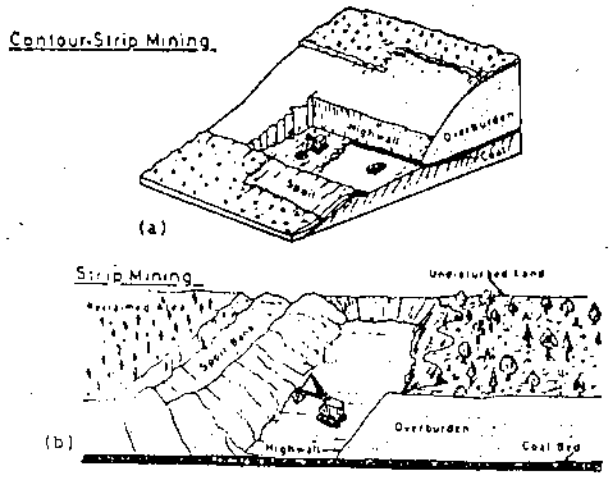

Fig. 10.1. Contour-strip mining in hill terrain and stripmining in flatter country. The top soil is scrped off and stacked away, and the overburden with debris systematically heaped in continuously excavated parts to be levelled, covered with soil and afforested eventually (From E.K. . Environmental Geology, Bell and Howell, London 488 p., figs. 13.16 and 13.17)

Top soil can be preserved and stacked away safely for later use (Fig. 10.2). the over burden from the contiguous cut is dumped in the trench formed as a result of removal of Ore from the first cut. This process is continued until the last trench is excavated. Then the ridge of dumped debris are levelled and covered with the top soil that had been safely stacked apart.

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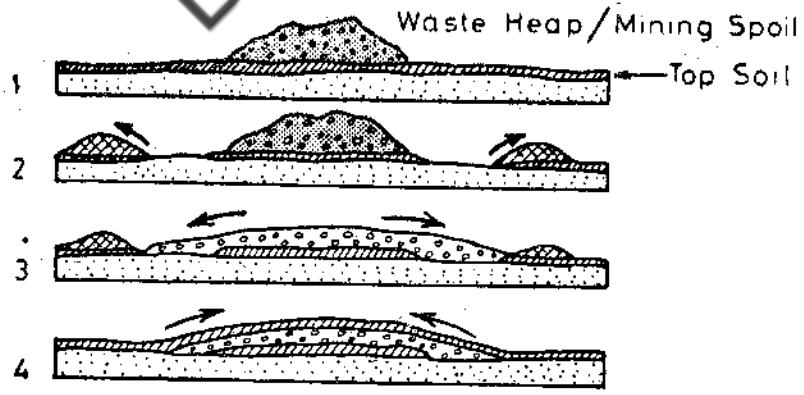

Fig. 10.2. Method of covering an infertile mining waste or spoil with a mantle of nutrient-rich topsoil, that was earlier scraped off and stacked away. This measure would not only prevent pollution of water by the mining waters, but ensure restoration of the ground through afforestation, (After A.D, Bradshaw and M.J. Chadwick, 1980, The Restoration of derelict Land, Blackwell, Oxford, 317 P., Fig. 6.6)

10.4.2. Underground Mining

The subsidence of the ground over underground mines is a result of unscientific practices. A relatively slow process extending over decades, subsidence eventally

leads to drastic accidents such as floods, failure of dams, embarkments on the rivers that flow on the ground over the underground mines, collapse of buildings and destruction sewage, drains and canals.

Withdrawal of Oil and Gas from deeper reservoir result in the reduction of fluid pressure, culminating in the subsidence of the ground.

Underground fire in coal mines is yet another hazard which is difficult to control. The burning of coal means production of such gases as Sulphur Dioxide, Carbon Dioxide, Carbon Monoxide, Methane etc. together with coal dust. These gases cause great pollution to the area.

Adverse impacts on the Hydrologic system : Deeper excavation on the surface or underground digging, causes the water table to sink locally, often drastically, resulting in the drying up of wells and springs of the neighbourhood area. In the hilly terrain the process of excavation and attendant landslides obstruct the passage routes of undergroundwater.

Other Impacts : The mining operations like drilling, blasting, and other associated activities are carriedout in underground and open cast mines. Mining operations can damage the environment and ecology to an unacceptable degree, unless carefully planned and controlled. The following are some of the direct impacts of mining and possible solutions are suggested.

i. Visual Impact : Surface excavations, dumping of solid wastes and disposal of tailings in long time result visual impact. This impact can be minimised if the mines are located in sparsely populated remote regions away from highways. Preparation of landscape plan before starting operations will help in minimising the visual impact.

ii. Subsidence : Is another problem in the underground mining area. This impact can be minimised by starting the mining away from the areas of natural geological discontinuities (faults, joints etc.). The mined areas should be filled with sand or suitable packing material, cut and fill system of mining also helps to prevent subsidence.

iii. Noise : The three major categories of noise source in mining operations are fixed plant, mobile plant used internal and external transport movement. Fixed plant mechineries such as Crushers, Grinders, Conveyors, Ventilation Fans etc. generate noise and vibrations. This noise can be minimised by isolate the source or increase the absorption between the source and listerner by arranging noise insulating pads to the equipment and erecting the boundary wall to the mining premises. Developing the dense belt of trees, surrounding the mining area also minimise the noise impact.

Air Pollution : Air pollution caused by mining and associated activities can be classified into

a) Gaseous pollutants (SO_2, CO_2, CO etc.)

b) Suspended particulate matter (Silica, Flouride, Asbestos and Dust etc.).

Air Pollution can be controlled by arranging dust suppression and extraction system. In the case of open cast mines, the roads are to be sprayed with water to suppress dust;

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Transport equipment should be leak proof and properly covered. Dense belt of trees should be planted on road sides. These trees would serve as dust arresters.

Water Pollution : Water Pollution in the mining areas are mainly due to the 1) Pumping out of mine warer, 2) Pumping out of spent water from handling plant, dust extraction and dust suppression system and 3) Effluents from beneficiation plants etc.

Water pollution in the mining areas can be minimised by taking all possible steps to prevent the discharge of toxic effluents into the surface water bodies, groundwater acquifers. Effluents generated during mining should be treated to confirm the standards laid down by the pollution boards for prevention and control of water pollution before discharge. In addition to this the mine water can be utilised for irrigation of the plantations raised to stabilize the mine waster dumps.

Check your progress 1 & 2

1. What are the various types of mining ?
2. Subsidence of ground will occur in which type of mining ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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10.4.3. Oil Spills

Accidental or deliberate dumping of oil or other pertroleum products on to the ocean and its coastal waters, bays, harbours, or onto land or into rivers or lakes leads to oil spills.

It was estimated that spillage of oil into the marine environment would be a million tonns a year. Some of this spillage comes from off-shore well accidents. The substance of oil spills are mostly hydrocarbons, any or all of the materials in crude oil and its fractions. Especially toxic to various forms of marine life. Water birds, especially diving birds, are hard hit by oil slicks. Oil may be swallowed; nesting, mating or migrating activities may be seriously disrupted. Mollusks, Lobsters, Crabs are hard hit by the higher petroleum fractions of oil spills and by chemicals used in cleaning up oil spills, potentially oil pollution is the most serious long range danger to marine life.

10.4.4. Blow out

The occurrence of Blow outs is very common during exploitation for oil and gas. The Blow-out is a phenomena in which the outburst of gas with very high pressure will occur followed by burning of gas in the atmosphere causing huge flame may go upto a hight of 100 to 150 mts. This phenomena may occur during the exploration or exploitation of gas fields. Many such blow-outs occurred in India and abroad. However the gas blow-out occurred recently at Pasarlapudi, near Amalapuram, East Godavari District, A.P. is said to be the biggest and took long time (almost sixty days) for successful capping.

The continuous discharge of burning gas with occassional spills of oil under very high pressure naturally will cause some environmental problems. It is said that the most important environmental impact due to the gas blow-out will be the acidification of surface waters, soils and groundwater. The effects will be

1. declining pH of water (this affects the exchangeable cations in the soil).
2. considerable decrease in the alkalinity of soils (loss of carbonates and bicarbonates).
3. Release of Aluminium and other metal ions from soils into atmosphere.
4. Enrichment of groundwater and surface waters with released cations from soils causing pollution.
5. Pollution of air due to unburnt gas and due to the emission of CO_2 and CO.
6. Disturbances in ecology resulting damage to micro and macro organisms.

10.4.5. Nuclear Accidents

The environmental problems associated with the civilian atomic energy begin at the mine. There are four major problems. First is the gradual accumulation or low level emissions of radioactive pollutants from a growing number of reactors. Second is the danger caused by human error or an act of nature (Chernobyl, Russia). Third is the problem of disposing intensive radioactive wastes from the present and future reactors. And the fourth problem is security, against sabotage of nuclear power plants, against accidents in handling and transporting spent fuel elements to reprocessing plants, and perhaps the most important of all, security against the diversion of plutonium to military activities. The danger that some plutonium might be stolen and diverted to military use for a nuclear blackmail. Security measures for preventing theft of plutonium have not been devised and tested.

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10.4.6. Discharge of Groundwater

The withdrawal of groundwater causes depletion of the water reserves, and manifest in the lowering of the water table. The pumping out of water creates a cone of depression in the water table around the well, if the rate of inflow is less than the quantity withdrawn. A large number of wells discharging large quantities of water cause general lowering of the water table. This is called overdraft of groundwater as is seen in parts of northern Gujarat and Western Rajasthan. The culmination of overdraft is complete depletion of the groundwater reserve. As a result of lowering of the water table, shallow wells go dry and the springs and streams loose their waters. In the coastal belts, saline sea water encroaches upon the depleted reservoirs, rendering the reserves unfit for consumption as in the coatal areas of Saurashtra, Visakhapatnam (A.P.) and 24 Paraganas (West Bengal).

An overdraft of groundwater causes subsidence of the ground surface over the depleted acquifer constituted of unconsolidated or poorly consolidated sediments. This happens because of the reduction of the volume of the acquifer. In orde to avoid this situation, it is better to know the limit to which the water can be withdrawn without depleting the reserve and the rates of withdrawal must take into consideration of the rate of recharge.

Check your progress 3 & 4

3. Oil spillage generally occur and spreads easily in which environment?
4. Overdraft of ground water in coastal belts causes the

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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10.5. SUMMARY

Mining is the second largest activity after agriculture. Until recently mining was considered as desirable objective and the pollution of land, air & water was accepted as unaviodable. But now the industrial revolution demands more mining activity, thus causing environmental pollution. In our country mining activity is spread-out all most all parts of the country for extraction of 65 minerals from more than 4000 mines with more than 80,000 hactors of land under mining stress.

Mining is of two types namely open cast mining or quarrying and underground mining. Open cast mining involves two methods, in the first method known as contour-strip mining, removal of overburden and mining of ores is made with a series of benches formed, mining of this type induces landslides and erosion. The second method called area-strip mining-cutting of trenches results in extensive deforestation, destruction of top soil, lowering of water table and pollution of surface water. In the underground mining the environmental impacts are subsidence, noise pollution, air pollution and water pollution.

Accidental or delibarate dumping of oil on to the sea waters is known as oil spills. These are toxic to seveal marine organisms like mollusks, lobstors, and crabs. Water birds may also effected.

The occurrence of blow outs is common in the process of exploitation of oil and gas. Blow out is the out burst of gas and burning of gas in the atmosphere causing huge flame. The most important environmental impact with gas blow outs will be the acidification of surface water, soils and groundwater.

The environmental problems with nuclear materials are of (1) low level emission of radioactive pollutants in mining (2) accidents caused by human error or by nature (3) Disposing of large scale radioactive wastes and (4) Security against transportation and processing.

The withdrawal of groundwater cause depletion of water resources, lowering of water level and sea water intrusion. The discharge must be maintained based on the recharge of the system, otherwise the environmental problems will develop. The overdraft may also cause the subsidence of the loosely consolidated sediments.

10.6. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Open cast and underground mining.

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2. Underground mining.
3. Marine environment.
4. Encroachment of sea water.

10.7. MODEL EXAMINATION QUESTIONS.

I. Answer the following questions in 30 lines.

1. Describe the different types of pollution occuring in exploitation of resources.
2. Describe the possible solutions for minimising the impacts of mining on environment.

II. Answer the following questions in 10 lines.

1. Write briefly about the mining scenario of India.
2. Write briefly about the preservation of top soil.
3. Give a brief account of the adverse impact of mining on hydrologic system of an area.
4. Describe the over draft of groundwater and its consequences.
5. Give a brief account of the possible causes of nuclear accidents.

BRAOU

Dr. V. V. Nageswara Rao

UNIT-11: ENERGY RESOURCES - ENVIRONMENT

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  11.4.3. Energy from Winds and Waves
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  11.4.5. Energy from Biogas
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11.5. Summary
11.6. Check Your Progress : Model Answers
11.7. Model Examination Questions

BRAOU

11.1. OBJECTIVES

At the end of this Unit you will be able to :

* describe the environmental problems associated with the mining of coal and petroleum,
* describe the alternative energy sources,
* explain the environmental problems with energy sources.

11.2. INTRODUCTION

Abudant and dependable sources of energy are vital to the social and economic welfare of any Industrial nation. Energy resources including fossil and nuclear fuel as well as solar, tidal and geothermal energy may be recovered or captured and converted into other energy forms for a variety of house hold, commercial, transportation and Industrial applications that enrich the human environment. Energy sources, particularly in the energy conversion step where resources, are consumed to produce power, have been identified as major contributors to air and water pollution and to the despoilment of land. Environmental factors threaten the integrity of biosphere.

The rate of energy consumption is determined by the economic and technological development of the country. India which has 15% of the World population consumes nearly 1.5% of the total energy generated whereas U.S.A. with only 6.25% of the World population consumes nearly 33% of the total global energy produced. In India, about 73% of the total demand for energy is for commercial use. The source of this energy is either coal, oil or hydro electricity.

11.3. CONVENTIONAL ENERGY RESOURCE - ENVIRONMENTAL PROBLEMS

Conventional energy resources like fossil fuels (Coal & Petroleum) are finite and the demand for these resources are increasing day by day. It is well known fact that burning of fossil fuels cause serious air and water pollution. Moreover, considerable environmental degradation (including scarification, mass movement, deforestation and damage of hydrological systems) is caused by the mining or exploitation of these materials.

11.3.1. Coal

Coal mining is a hazardous enterprise adversely affecting both man and nature. Exploitation of coal denudes natural reserves and in the process takes its toll of both the environment and the people engaged in recovering coal.

In Eastern India (i.e. the Raniganj - Jharia coal belt) coal is primarily mined from underground mines, a number of them especially in the Raniganj area run to considerable depth as the upper seams have been exhausted. Most of the open cast mines are located either in the central coal fields (Giridih-Hazaribagh region) or in the Western Coal fields (M.P.). The importance of open cast mining increasing in the coal sector. Older coal fields of Eastern India increasingly proving to be a public menace with large scale land subsidence and underground fires depleting the precious resources of high grade coal as well as endangering overground habitation.

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Effects with Coal Mining.

i. Deforestation : With the growth of coal mining, forests were cleaved to set up coal mines. The exploitation of coal meant that it had to be transported from the mine to the industrial areas where it could be used as a source of energy. The residents of forest areas, the tribals, were increasingly displaced from their natural habitat. The deforestation in the coal region even brought a drastic change in climate. The coal mining regions were transformed into a hot & dry climate. Deforestation not only brought about climate changes but also accelerating soil erosion.

ii. Subsidence : Subsidence of land in the coal field area is not new. As the pillars of abandoned mines gave way either through erosion by water accumulation or because of vibration caused by overhead rail traffic or from blasting in neighbouring mines, the surface land subsided. Many areas in the Raniganj belt have experienced subsidence. In Jhariya, it is not water but fire which is posing the problem of land subsidence, underground fires are now posing a major threat to the Jhariya township itself. Underground fires could have different sources.

iii. Solidwaste : Coal mining and transportation involves emission of fugitive dust which is unavoidable and has a major share in air pollution.

The air pollutants released by combustion units include oxides of Sulphur, Nitrogen and Carbon as well as particles of ash, hydrocarbons etc. Most of these substances may undergo transformation by a variety of chemical reactions, which can effect natural ecosystems as well as human health over a broad region.

11.3.2. Petroleum

Several environmental problems accompany with the production, refining and transporting of liquid petroleum. Land is disturbed by onshore drilling and by pumping petroleum and sending through pipe lines. Drilling produces brine wastes. Offshore oil production and shipping constantly generate oil spills. The large ocean going tanker is the least expensive form of transportation for oil, with an on shore pipe line not far behind, but both have the potential to be involved in catastrophic oil spills.

The use of petroleum products generate a number of familiar environmental problems. Virtually all types of major air pollutants are made directly or indirectly by burning petroleum liquids - Hydrocarbons, SO_2, NO_2, Ozone, CO, CO_2 etc. In these conditions, we have no other way except to seek alternative renewable, preferably non-polluting sources of energy.

Check Your Progress 1 & 2

1. Underground coal mining is being carried out mostly in which part of our country?
2. Explain effects of deforestation ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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11.4. NON-CONVENTIONAL OR ALTERNATIVE ENERGY SOURCES

Substitution of alternative energy resources are useful for controlling environmental effects. The selection among alternative non-conventional resources depends on their relative abundance, easy recovery, convenience in handling and economics. The major alternative energy resources that can supply energy continually to the biosphere over a geological time span include solar energy and its derivatives, wind, waves and hydropower in addition to the energy from geothermal, biomass and Nuclear reactions.

11.4.1. Energy from Solar Radiation

The basic principle in this is to convert the solar radiation into the electricity without polluting the ecosystems. The radiation can be converted directly into electricity during the day by photo voltaic cells and stored in batteries. The indirect method of tapping solar energy involves concentrating the sun rays by use of mirrors or blackened collectors on water to produce steam that runs an electric generator.

Solar energy has been successfully used in various parts of the country to run tube wells, rice mills, lighting the homes etc. In India bright sunshine (solar radiation) are available in almost all parts of the country. The states of Rajasthan, Gujarat, Western Madhya Pradesh and Northern Maharashtra receives high quantity of solar radiation.

11.4.2. Energy from wind

The motion of wind is conveyed to the dynamo to generate electricity. The electricity so generated can be utilised immediately, stored in batteries, or fed into the Regional

Power Grid. A wind mill system of 20 towers can supply the electricity needs of a small town.

In India, the states of Gujarat, parts of Rajasthan, Western Madhya Pradesh and Coastal belts have high wind speed. During the monsoon months, the wind speed is very high. This wind energy can be tapped and fed into a regional grid.

11.4.3. Energy from Tides and Waves

Kinetic energy from the vertical motion of waves and the horizontal to and fro rolling movements of tides can be converted into electric energy in estuaries and bays, such as in the Gulf of Kutch, in the estuaries and deltas of the Kaveri, Godavari and Ganga rivers. The movement of waves and tides are rendered unidirectional by using a variety of mechanical devices. Tides being stabler than the seasons have greater potential for generating electricity.

11.4.4. Geothermal Energy

Thermal energy is stored in the earths crust upto a depth of 3 Km. is manifested in the form of rising geothermal gradients. The surface and groundwater, that is able to reach great depths in such geothermally live basins, gets heated and even converted into steam. The steam charged hot waters reappear on the earths surface as hot springs and geysers. There are three ways in which geothermal energy can be utilised. First, the hot waters and super heated dry steam can be directly conveyed to power plants to operate the generator turbines. Second, the surface water is injected into fractured rocks in the seep interior of the geothermal area through deep wells in order to heat and vaporise it. It is then brought back to run the turbines. Third, the heat exchange containing liquid having a low boiling point is immersed in the underground well. The liquid vaporizes and returns to the surface and runs the generator.

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In India several springs and hydrothermal systems are reported in several states, that are useful to tap geothermal energy.

11.4.5. Energy from Biogas

Biogas, from which energy can be generated, is formed as a result of fermentation of dung of cattle, human excreta, crop wastes, garbage, and aquatic weeds. Fermentation takes place at temperatures higher than 28°C. Hence the biogas plants are efficient only under warmer climatic conditions. The fermentation of the biomass, carrided out by aerobic bacteria, produces hydrocarbon gases predominantly methane (70-60%) with CO_2 (30-40%) and H_2S, N_2 in small quantities. The residue left in the tank is rich in nutrients and can be used as a valuable manure. The Khadi and Village Industries Commission pioneered the movement for constructing biogas plants in the country.

India has enough resources of raw material for the production of biogas, which is an alternative source of energy for cooking and other purposes.

11.4.6. Nuclear Energy

The Atomic Energy Commission is aiming to install Nuclear Power Plants. One kilogram of natural Uranium U_{238} generates as much energy as 35,000 kg. of coal. India has the commercially exploitable Uranium reserves mostly at Jaduguda, in Singbhum district of Bihar and very subordinately in Meghalaya, M.P. and Karnataka.

Nuclear power generation programme will require large quantities of U_{238} to feed the reactors. The spent fuel material contains unused U_{235} and plutonium PU_{239} are deadly pollutants. These nuclear wastes are being reused as a fuel in the fast breader reactors, such as Kalpakkam, India.

In view of limited reserves of fossil fuels like coal and petroleum, and the present high cost of generating energy from hydrothermal and other sources, India has to embark nuclear power generation programme. Great care is needed to control pollution and accidental leakages.

Check Your Progress 3 & 4

3. Geothermal energy is stored in

4. Which uranium element is useful for nuclear energy ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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11.5. SUMMARY

BRAOU

Energy is vital to the social and economic welfare of any nation. Energy resources are of two types, conventional sources like fossil fuels namely coal, oil and gas and vegetation. These are non-renewable source, it means one can not create after exhausting. Non-conventional resources are renewable resources, which can not be exhaust. These are solar energy, wind energy, geothermal energy, biogas, and nuclear energy. Energy resources during the energy convension step have been identified as major contributors to air and water pollution.

Exploitation of coal with mining cause natural toll of both environment and the people engaged in coal mining. The environmental problems with coal mining are the 1. Deforestation and displacement of tribal people 2. land subsidence and underground burning of coal and 3. solid waste disposal. Burning of coal to generate energy, is releasing pollutants like oxides of sulpher, carbon, nitrogen into the air.

Environmental problems with petroleum are due to exploitation, production refining and transportation. Land is disturbed with drilling, drilling produce brine waste, transportation with shipping generate oil spills. The important air pollutants namely SO_2, NO_2, Ozone, CO, CO_2 etc. are releasing directly and indirectly through burning of petroleum liquids.

Non conventional energy resources are useful for controlling environmental effects. Solar energy will be obtained from the sun without polluting the ecosystem. The solar radiation can be converted directly into electricity by photovoltaic cells during day time. Solar energy has been using to run tube wells, rice mills and lighting the homes.

The motion of wind is conveyed to a dynamo to generate electricity. The energy generated can be utilised immediately, stored in batteries or fed into electric grid. Waves and tides are also useful to generate electric energy by using mechanical devices.

Thermal energy stored in the earth crust is called geothermal energy. Groundwater gets heated and even converted into steam with this energy. The steam charged hot waters on the earth surface as hot springs and gases. These hot steam is useful to generate electric energy by using generator turbines.

Biogas is formed as a result of fermentation of dung of cattle, human excreate, crop waste, garbage and aquatic weeds. Biogas is an alternative source of energy for cooking and other purposes.

Nuclear energy will produced by fission and fussion process of nuclear elements. Uranium (U238) is useful to generate energy, great care is needed to control pollution and accidental leakage.

11.6. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Eastern India
2. Climatic change and soil erosion
3. Earth crust
4. Uranium $_{238}$

11.7. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Describe the various environmental problems linked to the mining of coal and petroleum.
2. Give a detailed account of possible alternative energy sources.

II. Answer the following questions in about 10 lines.

1. Why the search for alternative resources are required.
2. Give a brief account of solar energy.
3. Write briefly about geothermal energy and how it is useful.
4. Describe briefly about the nuclear energy.

BRAOU

Dr. V. V. Nageswara Rao

UNIT-12: WATER RESOURCES - ENVIRONMENTAL IMPACTS

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12.8. Sea Water Intrusion
12.9. Water Logging
12.10. Groundwater Quality
12.11. Carbon Dioxide in Wells
12.12. Groundwater Management
12.13. Conjunctive Use
12.14. Summary
12.15. Check Your Progress : Model Answers
12.16. Model Examination Questions

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12.1. OBJECTIVES

After completion of this unit, you should be able to :

* explain the water resources of India,
* define groundwater,
* explain the environmental effects with over exploitation of groundwater,
* explain the advantages with groundwater management.

12.2. INTRODUCTION

Water occupies about 71% of the earth's surface. But only 2.8% of the total water resource is fresh water. Out of this, 2.15% occupies snow peaks and glaciers, 0.6% as groundwater and only 0.01% in streams and lakes. Water changes its state of existence depending on the climatic conditions of a region and the earth at large. Water undergoes evaporation due to heat and becomes water vapour. Water vapour moves in the atmosphere, condenses in the regions of low temperature and reaches the earth surface as rainfall or precipitation. Rainfall then turns into run-off on the ground surface and forms streams which finally join the sea. Part of the rainfall infiltrates underground and becomes groundwater. A part of subsurface water also moves laterally and emerges as springs and seepages and join the stream beds. This path of water movement is cyclic, continuous and therefore called 'Hydrological Cycle' (Fig. 12.1)

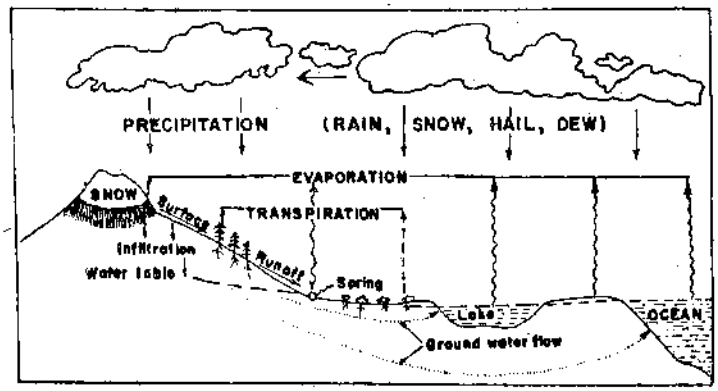

Fig. 12.1. The hydrologic cycle

Water resources of a particular region depends on the rainfall. India experiences arid to humid climate with abundant rainfall in most of the places. The average annual rainfall of the country is 1140 mm. But the distribution of rainfall varies depending on the geographical and topographic positions. Maximum rainfall is received in the western ghats with the highest recorded in Kerala State at more than 3000 mm. Another place of still higher intensity is Assam State in the northeastern region. The lowest rainfall is received in Rajasthan with about 150 mm. In Ananthapur District of Andhra Pradesh, the minimum is around 500 mm. At macro level rainfall varies with altitude. Hill peaks like Nilgiries, Shevaroys in Tamil Nadu, Ananthagiri hills of Andhra Pradesh receive high rainfall with nearly 3000 mm while the plains at foothills as at Coimbatore, Salem and S.Kota receive relatively low rainfall.

Topography plays an important role in the distribution of surface waters. As the subcontinent is tilted towards east, all the major rivers in the peninsula region like Krishna, Godavary and Cauvery flow towards east transporting waters from the Western ghats and join the Bay of Bangal. River Ganges in the north also has easterly flow.

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12.3. WATER RESOURCES OF INDIA

Dr. K.L. Rao estimated that the total input of water as rainfall in the country is of the order of 370 M.ha. m (million hectare meters). Evaporation loss is put at one-third of it. Run-off is 167 M.ha. m and 80 M.ha. m is infiltration into subsurface layers. Out of the infiltrated water, 37 M.ha. m is accounted as groundwater and the remaining retained as soil moisture.

Water locked up in the Himalayan peaks in the form of snow covers an area of 42,200 km^2. Himalayan river systems - Indus, Ganges and Brahmaputra - contain 20 to 30% of their run-off from snow melt. Hydrograph of a river is shown in fig. 12.2. The recession limb of the Hydrograph gradually tapers down. The flow that occurs after mansoon is called base flow which represent groundwater discharge from the catchment area. Ephemeral streams donot have beseflow.

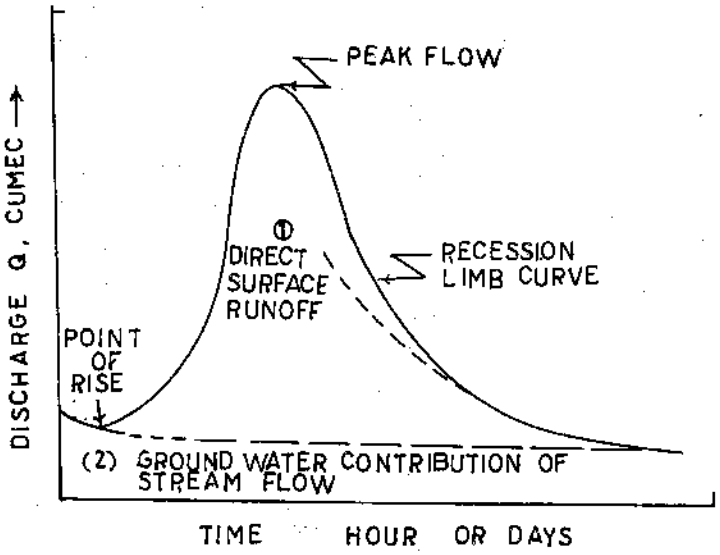

Fig. 12.2. Components of Streamflow Hydrograph

Water distribution on the earth is given in table - 12.1 Annual flow in the major Indian rivers is given in table - 12.2. In the total run-off 85% is through major rivers, 7% by minor rivers and 8% by ephemeral rivers. In the total available water of 191 M.ha.m, only one-third is gainfully utilised.

Table - 12.1: Water Resources of the Earth

Resource	Volume (Km^3)	Percentage
Atmosphere	13,000	0.001
Oceans	1,32,20,00,000	97.20
Icecaps and glaciers	2,92,00,000	2.15
Saline lakes and inland seas	1,04,000	0.008
Soil moisture	67,000	0.005
Underground	41,70,000	0.625
Rivers	1,250	0.0001
Freshwater lakes	1,25,000	0.009
Total	1,35,56,80,250 Km^3	100%

(A.N.Strahler, 1973 in K.S. Valdiya, 1987)

Table - 12.2: Approximate Water Potentials of Indian Rivers

Sl.No.	River Basin	Water potential M ha.m.
1.	West flowing rivers like Narmada & Tapati	30.55
2.	East flowing rivers like Mahanadi, Godavari, Krishna, Cauvery & Penna	35.56
3.	The Ganges and its tributaries	55.01
4.	Indus and its tributaries	7.95
5.	The river Brahmaputra	59.07
	Total	188.14

(Raghunath, 1985)

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12.4. GROUNDWATER

Groundwater plays a vital role in solving the drinking and Irrigation needs of the country. While it is the sole water resource in some parts, it supplements the surface water in other parts. It shares 40% of the total irrigation potential of the country. It tides over difficult situations in drought years when surface water exhaust. The total groundwater reserve down to a depth of 300 m is given as 370 M.ha.m. The estimated annual replenishable groundwater resource including seepage from surface water bodies is 46 M.ha.m. About one-fourth of this resource has been under utilisation thus leaving three-fourths for future development.

12.5. GROUNDWATER RECHARGES

Groundwater is replenishable unlike other mineral resources which are normally exhaustible in nature. The aquifers are recharged every year from the rainfall. Groundwater recharge of an area depends on the annual rainfall and its distribution, topographic gradient, vegetation and most important of all soil and rock permeabilities. The intake capacity in an area by infiltration of rainwater or surface water is limited to the permeability factor. It decides the amount of water that can be transmitted per day through the soil and the underlying geological formation. Any excess of water to this component would go as surface run-off. Therefore, rainfall of high intensity for short spell do not have as much influence on the recharge as the same amount of rainfall is distributed uniformly over a longer period. Similarly, the higher the slope of the ground, the faster the run-off and lesser the infiltration. A plain ground on the other hand, allows maximum infiltration as the run-off is slow and the contact between the water and ground surface is long. Vegetation helps to reduce the run off and indirectly helps for more groundwater recharge. Generally, 10% of the rainfall is considered as groundwater recharge. But this figure may vary from less than 10% in hard rock areas to about 30% in alluvial areas. Groundwater draft per year is restricted to the quantum of annual recharge which is called perennial yield or safe yield. When perennial yield of an area is estimated, groundwater recharges from all possible sources has to be taken into account. Other sources include recharge from surface water bodies like reservoirs, tanks, stream beds, canals and irrigation return waters. In the flood plains and areas close to stream courses, additional groundwater recharge may be induced from the river bed through pumping.

Recharge of unconfined aquifers takes place through infiltration of rainfall or surface water from the same area. But confined aquifers received their recharge only from their outcrop area i.e. where the aquifer is exposed to the ground surface.

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12.6. OVEREXPLOITATION

If the groundwater draft exceeds recharge, it leads to overexploitation. Overdraft of groundwater is undesirable as it causes declining of water levels to greater depths whereby groundwater development becomes uneconomical or the resource may gradually exhaust.

Monitoring of water levels in select dug wells (observation wells) all over the country for the last two and half decades indicated declining trends in some parts. The water

levels have gone deeper by more than 10 meters in some parts which indicate overexploitation. The areas with groundwater extraction at more than 85% of the annual recharge are classified as dark areas (overexploited). In Andhra Pradesh some areas in districts like Chittoor, Nalgonda, Karimnagar, Nizamabad and Urban areas like Hyderabad, Visakhapatnam reached this state. It is a known fact that many dug wells and bore wells dry up in summer and recoup again in rainy season. Government of Andhra Pradesh is framed groundwater legislation which may curb indiscriminate digging of wells and overpumping so that groundwater resource remain as a sustainable and dependable source of water.

Check Your Progress 1 & 2

1. Define safe yield or perennial yield ?
2. What is over exploitation ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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12.7. LAND SUBSIDENCE

Overexploitation of confined aquifers leads dangerous effect of land subsidence due to excessive reduction in hydrostatic pressure in the aquifers. Hydrostatic pressure increases with depth following the rule P = Wh where P is pressure, W is unit weight of water and h is depth. Correspondingly, the weight of the overburden also increases with depth. Confined aquifers, therefore, are subjected to heavy loads of sediment and the water context therein. The weight of the overburden is born partly by the aquifer skeleton i.e. solid grains of the aquifer materials and partly by the water content in the pores. When groundwater is pumped out, hydrostatic pressure in the aquifer is reduced. As a consequence, the weight of the entire overburden is borne by the aquifer materials. This results in the readjustment of the grains and compression of the aquifer. When groundwater recharge takes place, the aquifer regains its volume and comes to original position. Thus, the confined aquifer acts as an elastic body. But when the groundwater withdrawals far exceeds the safe yield for a long time, the aquifer compression becomes irreversible. Thus there will be a permanent reduction in the volume of the aquifer. The overlying aquiclude (clay formation) also undergoes compression due to squeezing of its water with increased load of the overburden in the changed condition. This results in land subsidence at the ground surface. There are reports of land subsidence to the extent of 3 to 4 m in Tokyo and Osaka in Japan, 7.5 m in Mexico city, U.S.A. etc. Recent reports of subsidence are in Singapore and parts of Calcutta city. Manifestations of subsidence are disruption of drains, pipelines, railway tracks and damage to buildings.

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12.8. SEA WATER INTRUSION

The coastal plains are exposed to the threat of seawater intrusion. Along the coast, fresh groundwater from the landside and sea water from the seaside come in contact at depth. Density difference between fresh water (density 1.0) and sea water (density 1.025) makes the fresh water to float above sea water. Elevation of water table above sea level controls the depth of interface between the two. Fresh groundwater occurs in the coastal plain even in the beach so long as the water table lies above mean sea level (MSL). According to Ghyben-Herzberg principle, the interface between water and sea water lies at a depth of 40 times the height of ground water level (water table or piezometric surface) above the mean sea level (Fig. 12.3). That is, if the water table is 1.0 m above mean sea level, the interface is at a depth of 40 m below the sea level. The interface fluctuates following the fluctuation of water table or sea level. Therefore, it is suggested not to disturb the interface by over exploiting groundwater in the coastal zone. If the water table is lowered, sea water intrudes landward and contaminates groundwater. If the aquifer is contaminated once, it is difficult to bring it back to the original state.

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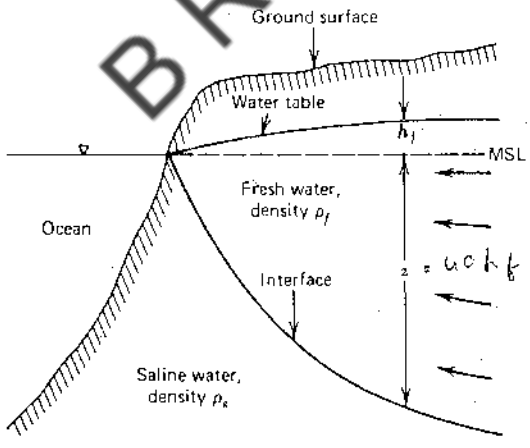

Fig. 12.3. Idealized sketch of occurrence of fresh and saline groundwater in an unconfined coastal aquifer.

A second possibility of contamination of groundwater in the interior parts of the coastal plain is due to sea transgressions in the geological past. Sea extended upto the foothills of the Eastern Ghats in some parts and retreated in four stages. Four starand lines (palaeobeach ridges) are identified in the coastal plain with the innermost located at 40 Km. from the present coastline. Even after sea regression longtime back, some

parts of the coastal plain still show the effect of seawater contamination and presence of connate water. It is a common observation in this area that pockets of saline water occurs admist fresh water zones laterally and also vertically at depth.

Check your progress 3 & 4

3. How does land subsidence will occur ?
4. Explain the possible reason for seawater intrusion ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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12.9. WATER LOGGING

Water logging occurs when water table rises close to the ground surface i.e. within the root zone of crops. Generally such a situation arises in the low lying areas like topographic depressions which receive groundwater seepage from the surrounding upland areas in addition to the rainfall recharge. New areas which develop this situation are command areas under major and minor irrigation projects without proper drainage facilities. The aquifers in those areas are recharged continuously apart from rainfall by the seepage waters from the reservoir beds, canals and applied irrigation water in the agricultural fields. The seepage factor depends on the permeability of the soils. Seepage losses from canals are high in the Indo-Gangetic plain varying from 33% to as high as 50% of the canal flow. Some parts in Guntur district under Nagarjuna Sagar command area are reported to be affected by water logging.

The effect of water logging is absence of aeration in the root zone of the crops which is essential for their growth. As a result, the crops have restricted growth and yields are reduced. Long term effects include salinisation of soils. Groundwater due to evaporation from the soil zone leaving the dissolved solids in the soils as residue. Such a phenomenon ultimately reduces the soil permeability and the area becomes unproductive.

Preventive measures to avoid water logging are to provide proper drainage channels to drain out the surface water and thereby restricting infiltration. Water logged areas

can be reclaimed by lowering the water table through pumping heavily from shallow tube wells. Lining of canals prevents seepage and thereby building up of water table.

12.10. GROUNDWATER QUALITY

Quality of groundwater is referred in terms of physical, bacteriological and chemical parameters. Physical parameters are taste, odour, colour and turbidity. Groundwaters, generally, are free from these problems as they are filtered through soils and aquifer materials. But they are disqualified under special circumstances even by these parameters. Taste of groundwaters is generally potable (good for drinking) except in case of high salinity. With the increase of salinity the water becomes brackish and saline. Unpleasant odour and taste are developed due to presence of some gases like hydrogen sulphide, organic compounds and minerals. Colour is imparted due to presence of organic matter and iron. Turbidity is due to presence of colloidal particles of clays, organisms and organic matter.

Bacteria and microorganisms are present due to pollution of groundwater. Coliforms indicate pollution from septic tanks. Guniea worm, a thread like worm with manifestation as boils on the arms and legs, is due to contamination in step wells. Pathogenic bacteria and virus are also reported in the groundwaters due to contamination from sewage which cause diseases like hepatitis, cholera etc. Chemical quality of groundwater can be gauged from the content of total dissolved solids (TDS) measured as mg/litre. PH is another parameter which indicates whether the water is acidic or alkaline. Chemical constituents exist in waters in their ionic state. Total dissolved solids constitute cations and anions. Major ions which make up the bulk composition of the water are sodium, magnesium, calcium and potassium among cations and chlorides, bicarbonates, sulphates and nitrates among anions. Fluoride, boron and metals like iron, manganese, arsenic, mercury, chromium etc. are present in minor and trace amounts. Certain elements even in minute quantities create health problems. Fluoride is a critical ion which should be present in the range of 0.5 to 1.5 mg/l. Flourosis, a bone disease, is caused when it is present in excess amount. It causes dental cavities when it is less than the minimum. Iron, if more than 0.3 mg/l, gives brown colour to the water and form sludge in pipes. Standards of drinking water prescribed by the World Health Organisation (WHO) are given in table-12.3.

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Table - 12.3: Drinking water standards (Potability) Prescribed by WHO in 1971

Constituents	Highest Desirable Level (ppm)	Maximum Permissible Level (ppm)
Total Dissolved Solids	500	1500
Anionic detergents	0.2	1.0
Arsenic	0.01	0.05
Barium	—	1.0
Cadmium	—	0.01
Calcium	75	200
Chloride	200	600

Chromium		0.05
Copper	0.05	1.5
Cyanide	0.01	0.05
Fluorine	0.8 - 1.7*	1.6 - 3.4*
Iron	0.1	1.0
Lead	—	0.1
Magnesium	150+	150+
Manganese	0.05	0.5
Nitrate	40	45
Silver	—	0.01
Sulphate	200	400
Zinc	5.0	15.0
BOD	9.51	9.20
pH	7.0 - 8.5	6.5 - 7.0

* *Varies inversely with mean annual temperature.*

If 250 mg/l of sulphate is present, Mg should not exceed 30 mg/l. (Data from Coates, 1981 in K.S. Valdiya, 1987)

For irrigation purpose, the general permissible limit of TDS is 1000 mg/l but there are different crops which can tolerate higher levels of salinity. Boron is a critical toxic element for plants. Other criteria for irrigation use are TDS, relative proportion of sodium to calcium and magnesium which is called sodium adsorption ratio (SAR) and relative proportion of bicarbonate to calcium and magnesium. If the sodium content is high, it reduces the soil permeability thereby reduces aeration in the root zone and turn the soils barren which do not support plant growth.

Quality of groundwater is generally controlled by topography, geological formation and soil covers. Total dissolved solids are relatively less in the groundwaters of upland areas and high in the low lands. Sediments like gravel and sand contain the best quality of waters with very low TDS while fine grained sediments like silts and clays contain very high TDS. Hard rock aquifers generally contain good quality waters. The weathered zones which are claycy substances contain relatively more TDS than fracture zones below. This is evident from the dug well and bore well waters with the latter generally yielding good quality waters. Shales and schists may yield poor quality waters. In some areas, the soil zone at the surface influence the quality of groundwaters since the rainfall infiltrates through it. Quality of groundwaters is generally poor with brackish nature in the areas covered with thick layer of black soils as observed in parts of Guntur district. Bore wells tapping deep fractures, however, may yield potable waters if the fractures are not recharged from the overlying soil zones. Basically, the groundwaters are generally potable where they are under continuous flow. The salts increase with sluggishness of flow or with increase in residence time in the aquifer. Ion exchange process is responsible for modification of chemistry of groundwaters within the aquifer.

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12.11. CARBON DIOXIDE IN WELLS

Carbondioxide, though, is not harmful when it is in dissolved state, it becomes a death trap when released from the groundwater and accumulates at the bottom of the well above water level, particularly, in deep wells. This happens during summer when the solubility of gas is reduced with increase of groundwater temperature. When people unknowingly get into such wells for some purpose, they meet instantaneous death due to asphyxiation. As a precaution, a candle or lantern may be lowered in the well before any body goes down. Presence of carbondioxide is indicated when the flame is putout. Sometimes methane gas may also be present (generally in coastal or sedimentary areas) in such case the lamp burns with popping sound. Methane is also dangerous to life.

12.12. GROUNDWATER MANAGEMENT

Groundwater development in the country has gained momentum during the last two and half decades because of institutional finance through banks. Some pockets in many states including Andhra Pradesh reached optimum stage tapping more than 85% of the groundwater potential which are classified as dark areas. Therefore, management techniques are needed to restrict the groundwater draft to the safe yield limit or to increase the safe yield itself through artificial recharge methods. There are other methods of management which involve change of crop-pattern and adoption or modern irrigation practices like sprinkler and drip irrigation which reduce the quantity of water applied and increase the area of irrigation. Reuse or recycling of waste water is also practised for certain purposes which donot require high standards of quality like irrigation, cooling etc.

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Artificial recharge is an effective measure to increase the recharge to groundwater. The methods include spreading of water in open areas such as percolation tanks, reducing the velocity of flow in the streams by constructing check dams, injecting water into deeper aquifers through wells and induced recharge from the river beds by pumping close to them. Natural infiltration in the catchment areas can also be increased by planting vegetation, contour bunding and reducing evaporation losses. Coastal aquifers are to be managed from a different perspective, that is, the interface between seawater and fresh water should be kept undisturbed so that sea water intrusion cannot take place. The above artificial methods can be followed to check sea water intrusion, where necessary.

12.13. CONJUNCTIVE USE

The latest concept of water management is conjunctive use of surface waters and groundwaters for maximum utilisation of water resource in an area and to bring as much land as possible under irrigation and to raise more number of crops in an year. In the tank ayacut areas, channel irrigation areas and even in the acute of major irrigation projects, surface water is not sufficient to raise second crop in the entire command area. The first crop called kharif is grown with the surface water and the rainfall during monsoon. The second crop called rabi crop is raised during December-March. For this crop in the absence of rainfall, the complete requirement of water is

to be met only from the surface water. Which may be inadequate. It is therefore suggested to develop groundwater in the command area to supplement surface water at the fag end stage of the rabi crop. Groundwater is generally substantial in the ayacut areas because of seepage from the surface water bodies in the upslope. Groundwater would also be advantageous in the ayacut areas to raise nurseries well in advance to the monsoon so that it will be ready for transplantation at the onset of monsoon and thus helps to advance the crop by about a month which leaves scope for the third crop during summer.

Check Your Progress 5 & 6

5. What is watter logging ?

6. What is index for chemical quality of groundwater ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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12.14. SUMMARY

Water occupies about 71% of the earth surface. Only 2.8% of the total water resources are freshwater (2.15% is snow, 0.6% groundwater and 0.01 streams and lakes). Water changes its form naturally from water to vapour and again water through hydrological cycle. Water resources of any region will depends on the rain-fall. The average annual rainfall of our country is 1140 mm. But the distribution of rainfall varies depending on the geographical and topographic positions. The highest rainfall is recorded from Assam region and the lowest is recorded from Rajasthan. In general hill peaks receives high rainfall when compare to plains at foothills.

According to one estimation the input of water as rain fall in our country is 370 million hector meters. Out of this evaporation loss is one third. Rain-off is 167 M.ha.m and 80 M.ha.m is infiltration (37 M.ha.m. is accounted for groundwater). Groundwater is replenisable and plays vital role in solving drinking and irrigation needs of the country. Groundwater shares 40% of the irrigation potential. At present groundwater reserve down to a depth of 300 m. is 370 M.ha.m. About one fourth of this resource has been under utilization.

If the groundwater draft exceeds recharge, it leads to overexploitation and causes declining of water levels to greater depths. Overexploitation may also leads to land subsidence. This land subsidence will cause disruption of drains, pipelines, railway tracks and damage to buildings.

Sea water intrusion is the major threat along the coastal plains. Normally fresh groundwater is available even in the beach because of the elevation of water table above mean sea level. Overexploitation from such regions results the decline of

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groundwater table causing seawater intrusion into the fresh aquifers. Sea transgression in the geological past is also another reason for contamination of groundwater along the coastal plains.

Lack of proper drainage systems leads to water logging. The areas with water logging will receive groundwater seepage from uplands in addition to normal rainfall. New areas which develop this situation are called command areas. Due to water logging crops cannot give good yields and in course of time salinisation of soils will occur.

Quality of groundwater is referred in terms of physical, bacterial and chemical parameters. Physical parameters are taste, odour, colour and turbidity. Bacteria, and micro organising are present due to pollution of groundwater. Groundwater quality may deteriorate with urban waste, sewage, septic tanks, industries, fertilisers and pesticides, sea water intrusion etc. Quality of ground water is generally controlled by topography, geological formation and soil cover. Pollution of ground water leads to several health disorders to those people who conserved it. During summer season some times groundwater releases carbon dioxides and methane in deep wells. When people unknowingly get into such wells meet spot death.

Groundwater management techniques are needed to restrict the ground water draft to the safe yield limit or to increase the safe yield itself through artificial recharge. The other methods of management are change of crop pattern and adaptation of modern irrigation practices like sprinklers and drip irrigation. Conjunctive use is other method in which maximum utilization of water resource in an area to bring as much land as possible under irrigation to rise more member of crops in an year.

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12.15. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The annual recharge to groundwater from all sources is safe yield.
2. If the groundwater draft exceeds safe yield, it is called overexploitation.
3. In a confined aquifer system, when groundwater draft far exceeds the recharge for very long time, some parts of the land may sink down due to reduction in hydrostatic pressure and as a result in the volume of the aquifer and the overlying sediments, which is called subsidence.
4. When the hydrostatic equilibrium between fresh water and sea water is disturbed due to excessive pumping in the coastal area, water levels in the aquifers may decline. As a consequence, sea water rushes in.
5. If the water table rises near to the ground surface into the root zone of crops, it is called water logging.
6. Total dissolved solids (TDS).

12.16. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in 30 lines.

1. Write an essay on groundwater development and management.

2. Explain in detail the quality of groundwaters and their suitability for drinking and irrigation purposes.

II. Answer the following Questions in 10 lines.

1. Explain groundwater recharge and overexploitation.
2. How land subsidence occurs and what are the measures to control it.
3. How sea water instruction occurs in the coastal zone and how do you control it.
4. What are the causes for water logging. How do you prevent it or reclaim a water logged area.
5. How carbon dioxide is produced in the wells. What is its effect and what are the safe measures.
6. What are the factors influencing quality of groundwater.
7. Explain about conjunctive use of groundwaters and surface waters.

Prof. G. Krishna Rao

BRAOU

BLOCK - 4
DEVELOPMENT & ITS IMPACT

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UNIT-13: DAMS AND RESERVOIRS

Contents

13.1. Objectives
13.2. Introduction
13.3. Role of the Geologist in Development and Geotechnology.
13.4. Purpose and Types of Dams
13.5. Geo-engineering Aspects of Dams and Reservoirs
13.6. Environmental Problems
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  13.6.3. Evaporation Loss and Micro Climatic Changes
  13.6.4. Water Table and Quality Changes
  13.6.5. Ecological Changes
  13.6.6. Upstream Sedimentation
  13.6.7. Down Stream Erosion
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  13.6.9. Resettlement of Human Communities
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13.7. Remedies
13.8. Summary
13.9. Check Your Progress : Model Answers
13.10. Model Examination Questions

BRAOU

13.1. OBJECTIVES

After studying this unit, you should be able to :

* explain the role of the geologist in development and geotechnology,
* define the geo-engineering aspects of dams and reservoirs,
* identify the different types of Dams,
* describe the environmental problems with Dams and Reservoirs,
* define the alternatives to big dams.

13.2. INTRODUCTION

Nature consists of marvelous engineering works like bee hives, termite mounds, spider webs, bird nests, beaver dams, coral reefs etc. We are not unique animals. In our case we are designing and constructing larger structures. In this unit we discuss those effects that are produced when man design engineering projects for the use of water as a resource. Water is the essential ingredient in modern civilization and it is necessary to obtain, to store and distribute this to society. Dams and reservoirs are playing vital role in this process. In diverting water for human use, we are changing the natural hydrologic regime. This leads to disruptions of terrain, increased erosion and sedimentation in stream channels and reservoirs to land subsidence and faulting. Dams are now build for a variety of purposes like water supply, hydroelectric power generation, flood control, recreation etc.

13.2. ROLE OF GEOLOGIST IN DEVELOPMENT AND GEO-TECHNOLOGY

The Job of the engineer in the construction and designing of structures like dams, reservoirs, bridges, buildings etc is to assure us those services that are necessary for our livelihood and sustenance. Because earth materials are used and terrain is involved geologist rightly view their role as significant in the planning of such disturbances to the geologic environment. The big structures invariably affects the land-water ecosystem because we have imposed a new, artificial environment on to a natural setting. Geologic investigations that serve engineering purposes must cover a wide spectrum of specialities because no two areas have exactly the same type of rocks, structures, topography or physical processes that operate with in them. Most investigations take at least the following three basic forms.

i. **Reconnaissance Investigation :** This provides an overview and the generalised range of problems to be encountered. Alternative options should also be considered in this phase.

ii. **Feasibility Investigations :** This provides the detailed basis for the project - the plan, the budget, the working schedule, the source of material, the geologic constrains.

iii. **Construction Investigations :** This is an ongoing study that continues for the duration of the project. For example excavation work may reveal unanticipated problems that need resolution in a different manner than that planned.

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The preliminary work that is essential includes thorough review of all previous relevant reports, inspection of the geology, hydrology, topography and acting processes, and verification of features by test holes as well as geophysical studies. During the detailed study more precise information is needed, the location of trouble spots, and hazard conditions that must be stabilised so that construction is not placed in danger, in situ stress and pore water pressure, and an accurate assessment of all logs and other structural and material indicators. And finally there is no substitute for the continuous monitoring of all systems to assure conformance with all design specifications. Structural failures can usually be traced to inadequacies in determining the correct order of magnitude of stability of the geologic environment. Even after taking all available specifications into considerations, environmental degradation may occur because of inability to control all feed back mechanisms that operate in nature.

Check Your Progress 1

1. Identify the difference of roles played by the engineer and the geologist ?

Note : (a) Write your answers in the space given below.

(b) Compare your answer with the model answer given at the end of this unit.

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13.4. PURPOSE AND TYPES OF DAMS

To store water for irrigation, electricity generation and flood modification commonly solid barriers called dams are constructed across rivers, preferably at places where the volleys are narrow. Most of the dams serve more than one purpose. These are multipurpose dams. Of the 1554 - old major dams in India only 17 have been identified as flood control projects, their principle objective being irrigation and power generation. At best the dams can hold back flood water only upto a level. Keeping in view the geologic and geomorphic condition of the area, choice of the site of the dam is of crucial importance. The primary requisite for selecting a site for a dam, apart from adequate stream discharge, are the presence of narrow course, preferably a gorge with suitable foundation conditions and the availability of construction material. The geologic conditions of the foundations, nature of the construction material available and the seismicity of the area govern the choice of the type of dam. The dam type, the location, and the geologic foundation and conditions determine its safety. A thorough geologic investigation should proceed dam design and construction. Bore holes, testing programes, and rock mechanics analysis are vital to determine the rock composition, structure and strength. Such factors as permeability of rock units and pore pressures are significant components in selecting the appropriate engineering design and construction methods. Studies related to slopes and inundated materials into the reservoir pools are also essential. The main types of dams are

1. **Gravity Dams :** Such dams are adaptable to all conditions and locations and are composed of solid masonary that resists the forces made against them primarily by their weight (fig. 13.1a). Forces of water and sediment are stabilised by the vertical component of the dams weight on the down stream face. The underlying rocks must be sufficiently strong to resist stresses and still be well below the elastic limit along all places of the contact planes. The height of the dam depends on the shear strength and bearing capacity of the foundation rocks or material. 125m high Nagarjuna Sagar and 143m Srisailam dams on the Krishna river are resting on the Peniusular gneisses and cuddapah quartzites are masonary gravity dams.

2. **Buttress Dam :** If the valley is wide and the foundation rocks having varying strengths buttress dams can be constructed. It consists of a up strum-slopping deck of reinforced concrete that bears the load of impounded water, and vertical buttress aligned normal to the plane of this slab. The vertical buttress transmit the load of the deck and impounded water and accumulated sediment to the foundation. (fig. 13.1.b)

3. **Arch Dam :** If the valley is very narrow and the rocks exposed on the steeper valley walls and the river bed are strong enough to take the transferred pressures an arch dam can be built (13.1c). The dam is composed of a single or multiple concrete wall, curved in plan with its convex face up stream. The pressure of the water is transferred to the abutment through each horizontal arch ring. The abutments are very strong and immovable rocks. Only the weight of the structure is transferred to the base. Idukki dam across the narrow valley of the Periyar river in the Nilagiri massif, Kerala is the arch dam.

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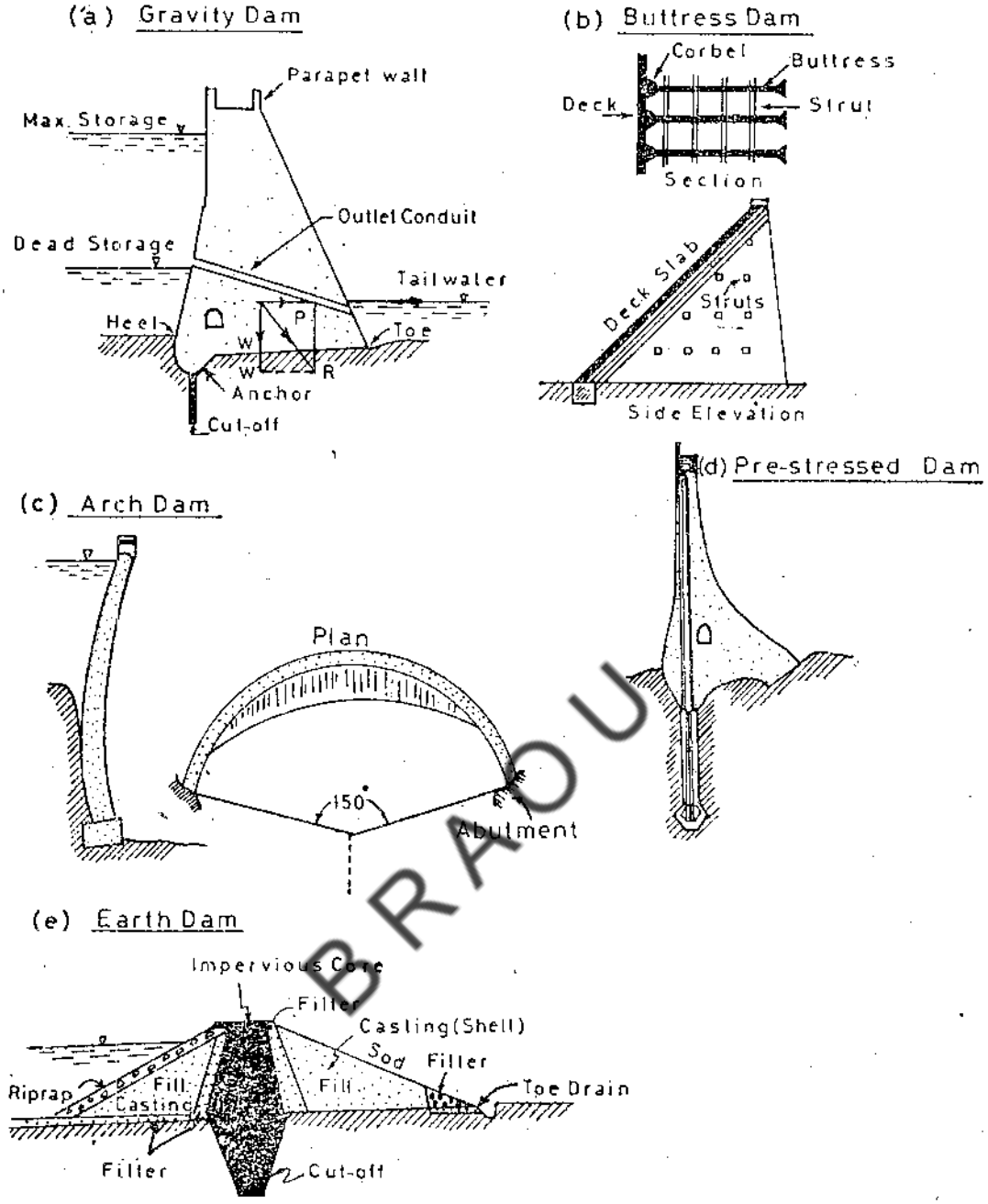

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Fig. 13.1 *Various types of dams. The cutoff (black) is made up of impermeable earth (a, e,). a, b, c based on D.P. Krynine and* W.R. Judd, 1957, Principles of Engineering Geology and Geotechnics, McGraw-Hill, New York, 730 p.

4. **Embankment Dam :** These dams are constructed of excavated materials placed with out addition of binding materials other than those inherent in natural material. An earth dam (13.1.d) is an embankment dam primarly composed of compacted earth. If the foundation can not bear the load of the heavy structure of the dam, there is alteration of weak and strong rocks in the foundation, the pressure of the impounded water and sediment and the shock of the earthquakes are high and val-

ley is wide, earth dam or rock fill dam (13.1.e) can be constructed. If the foundation consists of unconsolidated or loosely packed materials characterised by permeability, earth dams of height less than 30m are suitable. Some of the dams like Hirakud in Orissa and Bhavani dam in Tamilanadu are in wide valleys and are composite in structure i..e partly of masonary or concrete and partly of rock fill or earth dam.

Check Your Progress 2 & 3

2. What is a multi purpose dam ?
3. Where gravity dams can be constructed ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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13.5. GEO-ENGINEERING ASPECTS OF DAMS AND RESERVOIRS

Geo-engineering aspects are very essential for the design and construction of dams and reservoirs. The important aspects that are considered as vital are 1. The stability and failure of dams 2. Geological conditions of the foundation material and 3. Geology of reservoir areas.

The stability of the dams is derived from their weight-the heavier the structure the greater would be its stability. The forces which can reduces the magnitude of the vertical force acting downwards such as the uplift action of water infiltrated in the foundation or the horizontal force such as wave actions, floods and earthquakes will weaken the stability of the dam and may cause failure. To mitigate this key wall or cut off trench may be useful. Generally one-third of the failures are due to seepage. Over topping of the dam during floods is also one of the reasons of dam failure. So care must be taken in design and maintenance of dams.

The geological conditions to be verified for dam construction are the stability factors, structure of bedded rocks, knowing about shearzones and faults, testing of composition and texture of the foundation material, observation of the weathered foundation rocks, hidden topography, buried channels and seismological investigations.

The other important aspect is the geology of the reservoir areas. In this the investigation is mainly about the benefits and losses with dams, leakage and rize of water table, studies on sedimentation, reservoir filling and induced seismicity etc.

After studying and conducting all the above aspects the dam site and dam design will be undertaken. The various dams constructed and being planned are undeniably sound in terms of all the above said aspects. Even after taking care also environmental degradation is happening due to the uncontrolled nature.

13.6. ENVIRONMENTAL PROBLEMS

Dams can produce many desirable benefits and are essential for development. It is advantageous for recreation and power generation. Storing water for use during dry times with high flow is a desirable conservation type. Water is basic for personal consumption and industry. Hydroelectric is pollution free. Unfortunately there is another side of the story, environmental degradation result from water impoundments. Dams are therefore not to be viewed with in the restricted frame work of technical feasibility and economic gains, but are also to be assessed in terms of the environmental changes they produce and the socio-cultural impacts they would have on the communities effected. There are no provisions built into the frame work of plans for the elimination or mitigation of negative environmental and socio-cultural effects. If the project is to be rational and aimed at the welfare of the people there must be balancing or compensating each negative effect in the upstream area with a positive one in the downstream region. The environmental problems are discussed here under.

13.6.1. Erosion and Landslides

The impoundment of water causes the groundwater table to rise, creating new and recurrently changing gradients of the water table, as water is filled and withdrawn from the reservoir. The rise of the water table reduces the shear strength of rocks and soils and its fluctuation produces drastic alteration in the pore-water pressure. This phenomena promotes erosion and landslides along the banks.

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13.6.2. Reservoir - Induced seismicity

If the level of impounded water in a reservoir crosses the 100m mark behind the dams constructed in faulted, fissured, jointed or cavernous terrain of brittle rocks under condition of ambient stress, the frequency of earthquake increases. Some of the Reservoir induced earthquakes may be destructive like Koyna event in 1967.

13.6.3. Evaporation and Micro climatic changes

In a warmer country like our India, large amounts of reservoir water are lost through evaporation particularly during dry seasons. The larger the surface area the greater the loss. The loss of water thus defeats the very purpose of storing it.

The water body also produces micro climatic modifications in the lake basin and adjoining areas. The effected zone is cooled in early summer, but warmed towards its end. The summers are becoming shorter and more humid, and winters less severe. The net loss of heat now available to plants has effected their growth in forms and forests.

13.6.4. Water table and Quality changes

Groundwater conditions are changed both upstream and downstream of dams. New water table gradient is established with the rising and lowering of the water surfaces in the reservoir and down stream channel. Such changes may produce drastic pore-water pressure alterations and bank storage shifts, can become sites for landsliding and a threat to the safety of structures and society. In arid areas flucutations in water table can accelerate direct evaporation of soil water and lead to increase in soil salinity. This in turn affects the water quality and impairs its use for irrigation and other purposes.

13.6.5. Ecological changes

Dams may destroy the habitat of special flora and fauna, by smoothening sites or in the changed character of downstream releases. Water from impoundment is physically and chemically altered. The pH will be more acidic dissolved solids are more, temperature may be significantly different. The submergence due to impoundment of water causes loss of forests with this phenomenon is related the exodus of fauna and the loss of biological diversity and the resulting invasion of pest weeds. Aquatic communities are variably affected with reservoirs.

13.6.6. Upstream Sedimentation

First effect of a dam is to reduce flow velocity as the river enters impoundment barrier, the entrained sediment is deposited on the floor of the reservoir. In time there can be upstream growth and extension of the man made delta whose sediments fill other structures and tributaries. The life span of reservoirs throughout the world is being greatly shortened by the influx of these silt and sediment loads.

13.6.7. Downstream erosion

Devoid of suspended silt, the water released from the reservoir has a strong propensity for eroding the stream bed in order to satisfy its capacity of bed material. The stream bed is deepen and lowering of the base level induces a new cycle of erosion and attendant geomorphic changes in some of the downstream tributaries. While the area immediately downstream suffers from erosion, further down stream there is choking of the channels. It is not the deepening of the main stream that matters much, rather the initiation of new cycle of erosion in the entire drainage network that would manifest in the form of gullying of the catchment.

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13.6.8. Fallout of canal irrigation

Over-irrigation of the command area causes extensive water logging in the moist regions and salinization and alkalization in the dry regions. Water more than necessary has caused rise of the groundwater table, which reaching close to the surface, retards plant growth, creates problems in foundations and converts depressions into marshes or pools. Capillary action in drier areas brings up salts and corbonates of calcium and sodium from the depth of ground rendering the soil sterile and unfit for cultivation for all times. This situation is happened in the irrigated areas of punjab and Haryana.

13.6.9. Resettlement of human communities

The inundation of a large part of the catchment area results in the destruction of the best part of the croplands in the mountains and hills-usually the fertile terrace and most floodways in the plains, which are comparatively densely populated tracts. The submergence of valuable fields and settlements not only causes uprooting of large communities but also puts a halt to food production of the area. The disruption of the established pattern of social organisation and their psychological impact-distress, grief and trauma results with resettlement. Resettlement involves large amount of capital. The attitudes the culture, the sensitivities and aspirations will be changed. In general the population of people threatened with displacement would have grown considerably. Therefore the number of people resettled is much larger than expected. One more problem is the compensation may not be used for proper things;

so much care must be taken for the resettlement of human communities.

13.6.10.Submergence of Mineral deposits.

The inundation with water will cause loss of mineral resources. In the Mirzapur district of U.P. minor deposits of abrasives were submerged with Rihand Dam. In all most all cases the quarries of construction material will get submerged.

Check your progress 4 & 5

4. What are the three important aspects of geo-engineering in dams construction?
5. What happened in Koyna in 1967 ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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13.7. REMEDIES

Proper planning, designing for the construction of the dams is essential. Apart from this scientists are advising for alternatives to big dams. The construction of large dams are causing large damage to environment. Taking this into consideration smaller dams are suggested for irrigation and power generation. The lower cost of construction and maintenance, shorter duration of completion time and lower loss of electricity in long distance transmission would not create too many environmental problems. Several developed countries are constructing smaller dams only.

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13.8. SUMMARY

Dams and reservoirs are playing vital role in the development of society. Dams are changing the natural hydrologic processes, leads to disruptions of land terrain, erosion and sedimentation, subsidence and faulting. Dams are now built for a variety of purposes like water supply, power generation, irrigation, flood control, recreation etc.

Role of the geologist in the development of structures is very crucial. In general the engineers designs structures like dams, buildings to assure us the services ignoring geological problems. But the geologist rightly view their role as significant because no two areas have same type of rocks, structures, topography and physical processes operating with them. Reconnaissance, feasibility and construction investigations are important to any geologist.

Dams are constructed preferably at places where the volleys are narrow. The primary requisite to select a site for dam are adequate stream discharge, presence of narrow course with suitable foundation material. The geologic condition of the foundation, nature of the construction material, seismicity of the area are important to design the type

of the dam. The dam type, the location and geologic conditions determine its safety. The gravity type dams are adaptable to all conditions and locations. Buttress dams can be constructed when the valley is wide and foundation rocks have varying strengths. If the valley is very narrow and rocks exposed on the valley walls are strong Arch dam is preferred. If the valley is wide and the foundation material is not that much strong an Earth dam can be constructed. Earth dams may be earth fill or rock fill dams.

The geo-engineering aspects of dams and reservoirs are the stability and failure of dams, geological conditions of the foundations material and geology of the reservoir areas. The various dams constructed are being planned in terms of all the above said aspects, but due to uncontrolled nature's influence environmental degradation is happening.

The important environmental problems are (1) Erosion and landslides (2) Reservoir induced seismicity (3) Evaporation and microclimatic changes (4) Water table and quality changes (5) Ecological changes (6) Upstream sedimentation (7) Downstream erosion (8) Fallout of canal irrigation (9) Resettlement of human communities (10) Submergence of mineral deposits.

To control all the above problems proper planning and designing of dams and reservoirs are very essential. One important thing suggested by several geologists to control environmental degradation to dams is construction of smaller dams for Power generation and irrigation. Several developed countries are constructing smaller dams which our country has to be followed.

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13.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The engineers plan and design a structure where the geologist selects the suitable site for the construction of structures designed by the engineer.
2. Multipurpose dam is one which is useful to store water, irrigation, Power generation, control floods, allows roadway to cross and recreation.
3. Gravity dams can be constructed at any conditions and locations.
4. The three important aspects of geo-engineering are the (1) Stability and failure of dams (2) Geological conditions of foundation materials and (3) geology of the reservoir rocks.
5. Earthquake was occurred in 1967 at Koyna due to reservoir induced seismicity.

13.10. MODEL EXAMINATION QUESTIONS

I. Write your answer in about 30 lines.

1. What is the role of geologist in the development and geotechnology.
2. Write about the purposes and types of dams.
3. What are the environmental problems with dams and reservoirs.

II. Write your answer in about 10 lines.

1. What are the geo-engineering aspects of dams.
2. Write about water table and quality changes with dams.
3. What is upstream sedimentation and down stream erosion.

Dr. P. Madhusudhana Reddy

UNIT-14: FOUNDATION PROBLEMS - BUILDINGS AND BRIDGES

Contents

14.1. Objectives
14.2. Introduction
14.3. Load and Strength
14.4. Ground Conditions
14.5. Foundation Design
14.6. Foundation Problems with Groundwater
  14.6.1. Swelling of Clays and Pore Pressure
  14.6.2. Internal Erosion
14.7. Foundation of Bridges
14.8. Summary
14.9. Check Your Progress : Model Answers
14.10. Model Examination Questions

14.1. OBJECTIVES

After studying this unit, you should be able to :

* explain about the structural load and foundation strength,
* describe the ground conditions suitable for buildings and bridges,
* define the foundation problems with groundwater,
* explain the foundation of Bridges.

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14.2. INTRODUCTION

In the earlier unit you have learnt about the role of geologist in the geo-engineering aspects of the structures. Now in this unit you may learn about the Foundation problems with reference to buildings and bridges.

Foundation problems are very serious in the construction of buildings and bridges much care is necessary to control this foundation problems. Otherwise several environmental problems will be developed. The foundations of buildings and bridges transmit the load of the structure to the ground, which must have the capacity or strength to withstand the pressure without impairment. The foundation design ensures the distribution of load over a larger area so that there is minimum pressure per unit area. The best example for good foundation design are the TajMahal, Qutub Minar etc.

14.3. LOAD AND STRENGTH

Whether it is a bridge or building, the load of the structure is borne by the foundation. The load consists of its own weight and the weights of the things resting on it. Then there are lateral forces generated by blowing wind or storms, rushing flood waters and ground acceleration due to earth quakes. The stability of the buildings and bridges

depends principally on the strength of the material of the foundation to resist compression (reduction in volume) and shearing (deformation or plastic flowage) and secondarly on the manner in which the loads are transmitted to the ground.

The engineering properties of foundation materials such as rocks, sediments or soils on which depends the stability of the structure includes shear strength, compressive strength, swell and shrink potential, permeability, erodibility and corrosion.

The shear strength of a material depends on the tendency of the constituent particles to stick together (cohesion) and the innate resistance, the particles offer to all sorts of movements. The sandstones with fine particles have higher shear strength than the coarser grained sediments. Higher porosity implies greater content of interstitial water and therefore lesser shear strength. It is observed that the bearing capacity of any ground is always determined from the strength of the weakest member of the succession.

The compressive strength represents the tendency or ability to resist decrease in volume due to consolidation and is a function of the elastic nature of the particles. Finer material like clays and silts have lesser compressive strength than the coarser material such as gravels and coarser sands.

The swell and shrink potential is the propensity of clay to attract water chemically. The water thus drawn inside the frame work of the clay crystals forms layers of molecules, thus causing the clay crystals to expand and their deprivation due to drying leads to shrinkage. Clays can expand 25% to 50%. Mere 3% expansion is sufficient to destabilise the foundation.

The permeability of a material is its ability to allow passage of water without impairment of its own internal structure. The erodibility of the soil is the ease with which water moving through the pore spaces can remove the constituent material away. Some materials are prone to weathering or erosion.

The stability and strength of the foundation depends on the shear and compressive strengths, structural deformation and the degree of weathering.

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Check Your Progress 1

1. What is the shear strength ?

Note : (a) Write your answers in the space given below.

(b) Compare your answer with the model answer given at the end of this unit.

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14.4. GROUND CONDITIONS

The ground may be made up of solid hard rocks very close to or exposed on the surface so that the foundation can be laid directly on it. Here the evaluation of structural homogeneity or defects and bearing strength of the rocks is undertaken before emplacing the foundation of heavy structures. Lighter structures can be placed

without special treatment of the ground. In case of weaker materials resting on stronger ones, it is the weaker mantle that will experience shear deformation and failure will result, where as in case of stronger layer overlies a weaker material, the stronger member will spread the load and thus reduce pressure on the weaker material.

The clays deform easily under imposed shear stresses leading to differential settlement. The presence of faults and shear zones do not necessarily mean an incurably unstable foundation. However weak material such as incompetent gouge and shattered material have to be replaced by concrete or other competent material before laying the foundation. It is therefore necessary to undertake intensive exploration, including test drilling and boring in order to determine the underground conditions, including groundwater regime, bearing strength of the overburden material. On the basis of the knowledge thus acquired and taking into consideration the economics of the project, the type or design of the foundation is selected.

14.5. FOUNDATION DESIGN

The footing of the spread foundation takes up the weight of the structure and spread it over a larger area so that the load per unit area on the foundation is less (fig. 14.1 a and b). The soil or overburden has low bearing strength, the foundation is made as a continuous reinforced concrete slab covering the entire area of the structure. This is a mat foundation (fig. 14.1 c).

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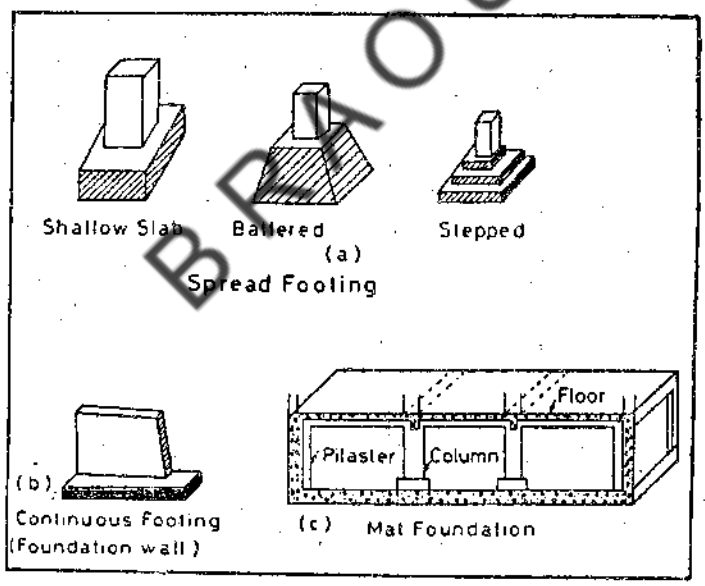

Fig. 14.1 The spread foundation and mat foundation ensure distribution of load over a larger area, and thus reduce the pressure per unit area to within the limit of the bearing capacity and shear strength of the foundation material. (Modified after D.P. Krynine and W.R. Judd)

In case the soil is very weak and prone to plastic deformation in the presence of water a box type foundation is preferred. The overburden is excavated down to the depth of the bed rock or hardened horizon and the space dug out is utilised for building a basement. Another method of building foundations on a very weak ground is to excavate continually beneath the foundation as the height of the structure rises so that the structure progressively sink to become a caisson foundation and serves as underground basement.

If the depth of the overburden is great and the material consists of gravels and loose aggregates of sediment a pier foundation or well foundation is made by drilling holes and filling the holes or wells with concrete, reinforced with bars of steel. If the depth of the overburden is not very great and the soil is free from gravelly material, piles of timber poles, steel or reinforced concrete are driven by mechanically hammering them to reach the reasonably firm material or up to a depth where the adhesive soil can counter the load through frictional forces acting on the piles.

A prior investigation is needed about the soil properties-compressibility and safe bearing capacity against settlement and overstressing under the foundation. If the investigation indicates high settlement potentiality, then it is necessary to do vipro compaction or grounting. In vipro compaction the poker vibrater or vipro-float can be penetrated into the soil to effect compaction of material and leads to reduction of intergranular spaces and increase shear strength. In grouting processes fluid that set quickly injected under great pressure into fissures, pores and cavities in ground. The common grout is the cement slurry.

Foundation along the slopes needs special precautions to ensure stability against slope failure. The factors to be taken into consideration are the structure of the bed rock, the angle of slope and the pattern of groundwater flow. Removal of loose burden, diverting of surface and groundwater flow are necessary for foundation on slopes. Grouting is essential to seal the openings and fissures. The foliated, jointed and bedded rocks must be bolted. The foundations are then keyed to the firm ground and cover the foundation with damp-proof coating and construct a drain which enables the water to flow.

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Check Your Progress 2 & 3

2. What is spread foundation ?
3. What is grouting ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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14.6. FOUNDATION PROBLEMS WITH GROUNDWATER

The areas where groundwater occurs at shallow depths, groundwater reacts with foundation materials and cause damage to the buildings and bridges. The two main problems to foundation material with groundwater are (1) swelling of clays and pore water pressure and (2) internal erosion.

14.6.1. Swelling of clays and Pore pressure

Materials like clay, loess and salts are more sensitive towards water. When ground-water comes in contact with clays, it leads to plastic deformation leading to failure of

foundation. Clays such as montmorillonite swell in the presence of water and cause damage to foundation. During dry seasons they shrink considerably. This differnetial settling, it means the alternate expansion and shrinking causes cracks on walls and buckling of floors. This is very common in Deccan and Malwa plateaus. Similar situation may be seen around limekilns and brickkilns where heat dries up the clays thus causing shrinkage.

Water present in soil or rock not only corrodes the foundation material but also reduces it shear strength. The infiltration of water buildsup pore pressure, threatening the stability of the foundation. In areas underlain by clays it is desirable to excavate the material equal in weight to the structure to be constructed.

14.6.2. Internal Erosion

The percolation of the underground may also wash away finer or soluble material from the fabric of the soil rock. This commonly happens when the water table rises or recedes due to heavy pumping or drawdown in reservoirs. The net result is internal erosion and differential settling. It is therefore essential to take into consideration the anticipated settlement problem and the foundation designed accordingly. There should be builtin provision for accommodating unavoidable settlement by Jacking up the foundation such as three point instead of four-point foundation and installing adjustable joint connections.

14.7. FOUNDATION OF BRIDGES

Bridge is an integral part of road or rail track. Bridge may be located after considering the requirements imposed by the grade and alignment of the route. The geologist role is not to suggest a suitable site or alternatives to bridges but to bring out the conditions of rocks or soils selected for placement of the terminal supports (abutments) and intermediate supports (piers). The geologist suggests the type of bridge on the basis of existing geological conditions and prevailing dynamics of the water of the river. There are many problems peculiar to bridges.

First part is that the ground is concealed under water, the knowledge of the geological condition of the foundation can be gained only by drilling and extrapolation based on an in depth study of the banks. Second the valley is filled with sediments of all kinds namely gravels, sands, clays etc, depending on the stage of maturity of the river which have variable bearing capacity. Third the load is transmitted through the structural design to the abutments so that the latter have to be very strong and stable. Fourth the bridge structure stands on a waterway as an obstruction and with stands the action of flowing nature of water, which is swift and scouring during floods. One of the consideration is the likely submergence of the bridge during floods and resultant threat of distabilization. Fifth in wide valleys filled with sediments, there is always a possibility of the existence of burried channels, pot holes, cavities and depressions. Thus a bridge must be safe guarded against erosion by rivers, damage by land slides, and rock falls and foundation failures. A thorough investigation is needed for the safety of bridges and to take remedial measures.

Not only the magnitude of forces transmitted to the foundation but also the manner in which the forces can be transmitted determine the design of bridge foundation. If the

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forces are transmitted vertically a simple beam bridge is the choice. The wider the river the deeper should be the penetration of the piers. In addition to vertical load there is a horizontal load, arch bridge is preferred. In such bridges anchoring the superstructure with cables to the rocks or concrete blocks are essential for the stability of the foundation.

Effective measures have to be taken against the possibility of settlement of the foundation as a consequence of load of the bridge structures plus the weights of rolling stocks. Unequal settlement may pose a threat to the stability. Spread foundation ensures the distribution of load and diminish the possibility of settlement. If a soft layer is present at shallow depth a pile foundation is necessary. Other measures of ensuring stability of bridges involves planning against the pressure of running water during floods, drifting of wood and ice blocks, storms, shacks of passing vehicles etc. The placement of a riprap around the piers and abutments is a precautionary measure. The abutments have to be safeguarded against such hazards like mass-movement, rockfalls and avalanches.

Check Your Progress 4 & 5

4. How swelling of clays happens ?

5. On what basis geologist suggests the type of bridge ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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14.8. SUMMARY

Foundation problems are very serious in the construction of buildings and bridges. So much care is needed to control foundation failure of buildings and bridges. The load of the structure is borne by foundation. There are several forces acting on the foundation, which are own weight, and the weights resting on it, flowing water, wind etc. The stability of the buildings primarily depends on the foundation materials. The engineering problems of such materials (rocks and soils) are the shear strength compressive strength, swell and shrink potential, permeability, erodibility and corrosion. The sandstones with fine particles have high shear strength. Finer materials like clay and silt have lesser compressive strength than coarser gravel. Clays reacts with groundwater then expands and during dry season again shrinks. This alternate expansion and shrinking leads to foundation failures.

The evaluation of structural homogeneity and bearing strength of the ground rocks is essential before laying foundation, lighter structures can be placed without special treatment to ground. In case the weaker material resting on stronger ones, it is weaker mantle that will experience shear deformation and cause failure, but in case of stronger

material rest on weaker one, no problem will develop. The clays deform easily under imposed shear stress. The weaker material may be replaced with concrete.

The footing of the bridge spreads weight of structure into larger areas. If the soil over burden has low bearing strength the foundation is made with a continuous reinforced concrete. If the soils are weak and are prone to plastic deformation, then it is excavated down to the depth of the bed rock. If the depth of the overburden is great and the materials consists of gravel and coarser materials pier foundation is needed. The investigation conducted reveals high settlement potential then vipro compaction or grounting is essential.

Groundwater in some areas reacts with foundation and cause damage to buildings and bridges. The problems in such cases are swelling of clays and pore pressure, and internal erosion.

Foundation of bridges are different to buildings in some aspects. Here the geologist role is not to suggest a suitable site but to bring out the conditions of rocks or soils selected for placement of abutments and intermediate piers. There are many problems peculiar to bridges. The magnitude of forces transmitted to the foundation and the manner in which the forces transmitted determines the design of bridge foundation. If the forces are transmitted vertically a simple beam bridge is the right choice. Other measures of ensuring stability of bridges involves planning against the pressure of running water during floods, drifting of wood and ice blocks, storms, shacks of passing vehicles etc. The abutments have to be safe guarded against such hazards like mass movement, rockfalls and avalanches.

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14.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The shear strength of a material is the tendency of the constituent particles to stick together (cohesion) and the innate resistance the particles offer to all sorts of movement.
2. In spread foundation type the footing of the bridge takesup the weight of the bridge and spreads over a larger area so that the load per unit area on the foundation is less.
3. Grounting is the process in which quickly set fluids injected undergreat pressure into fissures, pores and cavities to get compactness of the ground.
4. Whenever the groundwater table comes in contact with foundation material like clay. The clay absorbs water and swelling of clay result.
5. The geologist suggests the type of bridge on the basis of existing geological conditions and prevailing dynamics of the water of the river.

14.10. MODEL EXAMINATION QUESTIONS.

I. Write your answer in about 30 lines.

1. Write down about structural load and foundation strength.
2. What are the foundation problems with groundwater.

II. Write your answer in about 10 lines.

1. What are suitable ground conditions for bridges.
2. Write about the types of foundations for building & bridges.

Dr. P. Madhusudhana Reddy

UNIT-15: ROADS, CANALS AND TUNNELS

Contents

15.1. Objectives
15.2. Introduction
15.3. Route Alignment
15.4. Environmental Problems - Remedies - Roads
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15.6. Environmental Problems - Remedies - Tunnels
15.7. Summary
15.8. Check Your Progress : Model Answers
15.9. Model Examination Questions

15.1. OBJECTIVES

After studying this unit you should be able to :

* describe the route alignment,
* explain the environmental problems of roads, canals and tunnels,
* define the remedial measures to control environmental problems of roads, canals and tunnels.

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15.2. INTRODUCTION

Construction of roads and canals involves excavation on hill slopes and construction of embankments in flat country. On hill side cuts the main problem relates to the stability of hillslope, which depends on the structural condition and lithology. Excavation causes removal of natural support, leading to slope failure. It also produces landslides, causing destruction of forests and agricultural fields and irreparable damage to both surface and subsurface water systems, that causes drying up of springs and shallow wells. The main problems of canals are seepage and channel bed erosion.

Opening of a tunnel is virtually like opening an underground drain, and results substantial alteration of the groundwater system. In detail the problems and measures to be taken to control are discussed here below.

15.3. ROUTE ALIGNMENT

Roads are for connecting urban centres and must pass through places of habitation or special interest. Canals are dug to divert water from rivers and reservoirs to the places where it is needed. There is thus little or no option for selecting the general alignments of routes of transportation and of water conveyance. Geological and environmental problems must be investigated first along the chosen pathways for the safety. So road construction should be proceeded by geotectonical investigations to examine the bearing capacity and shear strength of the road bed, the stability of the slope of the cut and the conditions of groundwater. The construction of roads and canals causes drastic changes in the natural set-up and therefore the ecological balance, the environmental implications of these developmental projects are more serious to nature.

The main problem to route alignment is safety from hazards of mass movement on the hill slopes and ground subsidence in the plains. Excavations expose rocks and soils to process of weathering. Landslides that follow road-cutting expose much larger areas to disintegration and decomposition. The result is the loss of strength of the cut material and also the exposure allows percolation of water deep in side the rocks, thus promoting instability. The height and slope of the sloping wall of the cut should be kept approximately proportional to the shear strength of the rocks. The slope angle greatly influences the strength of the force causing slope failure-the steeper the slope, the greater the chances of failure. Erosion, landsliding and excavation steepen the slope and thus create conditions conducive to failure. The removal of material through excavation reduces lateral support and thus promotes downslope movement. The dumping of debris is adding load on an already destabilised slope. If the slope is very high it will be advisable to break it by developing horizontal beams or benches above the cut. The benches also serve to drain away water and trap the slide debris or rock falls.

Protective work at the early stage of road construction, particularly with respect to slope designs and resort to new road technology involving application of geotextiles or geomembranes as impermeable liners and fabrics as filter sheets on retaining structures, rock bolting and dowelling, reinforced structures, adequate drainage on the high way slopes, gabion mattresses and gabion walls would prove a less costly and safer from environmental problems.

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Check Your Progress 1

1. What are the main problems relating to alignment ?

Note : (a) Write your answers in the space given below.

(b) Compare your answer with the model answer given at the end of this unit.

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15.4. ENVIRONMENTAL PROBLEMS - REMEDIES - ROADS

Road construction has a considerable impact on the environment not only old landslides are reactivated but new ones also triggered in structurally vulnerable zones. The water table may be lowered. The blasting operation may cause widening of joints and fissures and resultant instability of slope. The cutting of the hillslope results in the intercaption of groundwater and consequent development of springs and seepages at the base of the wall of the cut. This leads to lowering of water table and resultant drying up of springs and wells on the slope. Another consequence of road cutting is the pollution groundwater due to infilteration of polluted water through fissures and openings. The pollutants are derived from fumes and droppings from petroleum run vehicles. This problem is quite minor and can be remedied easily.

The making of cut involves the production of a sizeable volume of debris and also there is debris formed by recurrent landslides during the rainy season. The debris is

invariably allowed to slidedown the slopes into the stream beds. This cause enormous damage to the down slope vegetation including forests and agricultural forms. The destruction of valuble forest has been equally serious. There are number of methods of dispose of debris. Debris can be used to build robust parapet walls all along the stretch of the road on the outer margin, the construction of parapet wall will provide safe guard against accidents. The debris can be transported for use elsewhere to use as construction material, as fill to develop playing grounds, parks and other structures. The debris can be stacked behind specially built retaining walls in the concave bends of road alignment and these sites thus formed will serve as parking places, tree forms, flower gardens, play grounds etc.

The liberal use of explosives for excavation has greatly weakened the hillslopes. This should be avoided with right spacing of short holes, keeping in view the strength, density and structure of the rocks. Road development involves stream-crossing and culvert construction. Ephemeral streams bringing debris loads on the roads can be ignored, but the problem of drainingout a concentrated flow of rainwater on the road beds is quite serious and cannot be overlooked. The effective remedy is construction of appreciably deep and wide drainage ditches on the inner side of roads in the hills which can be linked with the culverts and streams.

Stabilizing hill slopes or walls of road cuts is another important factor to control debris falling. It is advisable to avoid zones afflicted with instability, and prone to creep or related mass movements, and finds an alternative route across the valley. If it is not possible the walls of the road cuts can be stabilized with dewatering and drainage, reinforcement of slopes, afforestation and slope modification.

In the plain terrains the development of roads involves the construction of earthern or rockfill embankments. The differential settlement and attendant deformation of embankment manifest in bulging, wrinkling and spreading. Remedial measure involves intercepting and drainingout subsurface water through drainage ditches. This is also useful to solve drainage problems particular to groundwater.

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15.5. ENVIRONMENTAL PROBLEMS - REMEDIES - CANALS

The construction of canals involves not only excavating channels, but also, in the plains building up of embankments on both sides. Almost the same technology is applied in this case as in road embankment. The geological problems are similar to roads and were discussed in the earlier section. In addition there are two special problems that cause environmental changes are the seepage of water and channel bed erosion.

The diversion of stream water through the canal causes alteration of the entire ecosystem resulting physical and biological changes in the affected stream, particularly in the faunal and floral communities living down stream of the barrage or dam. Water flowing through a predetermined gradient and without natural impediments is uniformly shift. The result is appreciably greater scouring, compared to that in a natural channel. If the gradient is more results channel bed erosion. Therefore while constructing canals through arid, semi-arid and alluvial tracts care is necessary.

More than 25% of the water passing through unlined canals is lost by seepage. The impact of seepage is manifest in the waterlogging and salinization, alkalinization of soils. Measures to control this seepage from canals and reservoirs is by lining the canals.

Check Your Progress 2 & 3

2. What are the uses with debris ?
3. Identify some measures to stabilise walls of road cuts ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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15.6. ENVIRONMENTAL PROBLEMS - REMEDIES - TUNNELS

The principle concern of an engineering geologist involved in planning a tunnel along a proposed alignment is the identification and location of structural discontinuities or defects and lithological properties that may cause caving-in, overbreak and seepage of water. A self balancing system of shear stresses generates arching action that keeps the rocks or sediments from falling so long as the shear strength of the material above the opening is higher than the corresponding shear stress. A lining is provided to divide the weight of the overburden between the lining and the system of shears around the tunnel. The bedding, cleavage and foliation planes have an inherent weakness. The joint and fissures perpendicular to these planes aggravate instability. Where the principle planes of weakness are horizontal, the presence of the bridging effect will ensure stability, although transverse joints, if closely spaced, may also induce overbreak. If the tunnel is driven normal to the strike of a succession of steeply dipping or vertical beds, non uniform magnitude of the problem may not be serious. On the other hand if the tunnel is driven along the strike of the beds or foliations, very unsatisfactory conditions such as overbreak and seepage are likely to be developed, particularly where soft rocks alternate rapidly with hards rocks and where the succession is broken by faults or fractures. The rocks of the cores of the folds are high jointed and cleaned. In synclinal cores, blocks bounded by fractures / joints are likely to drop down, and the seepage under artisian condition may be very serious. In the anticlinal cores the conditions are comparatively better.

The faults associated with shearing and crushing of rocks are particularly vulnerable and prone to onrush of water and finer sediment. The pressure of gushing water and sediments may be strong enough to deform or break tunnel supports. Active faults are very hazardous in all respects and must be avoided.

Uncosolidated fine sediments like sands, silts and clays have lower shear strength, lower permeability, higher compressibility and greater sensitivity to water. The hydration of clays causes swelling and resultant generation of pressure in tunnels and on their linings. The lowering of pressure may also cause expansion of the unconsoli-

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dated clays. Even the stiff clays due to presence of close-spaced microscopic cracks disintegrate when put under the load. Therefore provision of support has to be provided at the very early stages of tunnelling through all kinds of clay masses.

The opening of a tunnel leads to substantial alteration of groundwater system. Not only are directions and rates of water movement changed, the water table also is lowered leading to drying up of wells and springs and dwindling of water in surface streams, flowing over permeable horizons. In order to minimise the problem of seepage in tunnels a simple method is to sink wells and intensively pumpout water so that the water table sinks below the level of the tunnel. Grounting of fissures, joints and faults, filling up of depressions in cavities and constructing a net work of drainage on the ground surface to drain out storm and surface waters are ecologically sound method of overcoming the problem.

Check Your Progress 4 & 5

4. What is the principle concern of Engineering geologist ?
5. How to minimise the problem of seepage in tunnels ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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15.7. SUMMARY

Construction of canals and roads involves excavation on hill slopes and construction of embankments on plain areas. The environmental problems related to this activity are the stability of the hill slopes and groundwater related problems. It also produces landslides and destruction of forests and agricultural areas. Opening of a tunnel is like opening of a underground drain. This processes leads to change in groundwater system and disturbs the ecological balance. Roads are for connecting places of habitation or special interest. Canals are dug to divert water from rivers and reservoirs to the places where it is needed. Geological and environmental problems must be investigated first along the chosen pathways for the safety. The construction of roads and canals cause drastic changes in the natural setup and therefore the ecological balance. The environmental implications of these developmental projects are more serious to nature.

Protective work at the early stage of road construction to slope designs involves the application of geotextiles or geomembranes. The important problems with road construction is the lowering of water table on the slope and pollution of groundwater

with the petroleum products of moving vehicles. These are very minor problems and remeditics are there. The second problem is the debris. The debris slide down the slopes and cause damage to vegetation. To control this problem debris may be removed and used some where else to prepare playing grounds, gardens etc. The liberal use of explosives has greatly weakened the hill slopes. Stability of slopes is another problems. To stabilise the walls of the road cuts there are methods useful like dewatering and drainage, reinforcement of slopes, afforestation and slope modification.

The environmental problems related to canals are almost similar to roads. Apart seepage and channel bed erosion are excess. If the gradient is more erosion will occur or if the gradient is less it results sedimentation. So proper maintenance of gradient is needed. To control seepage problem the only alternative is the lining canals.

The role of an engineering geologists in tunnel construction is the location of structural discontinuties or defects and lithological properties of rock materials and seepage of water. The bedding, cleavage and foliation planes have inherent weakness, the presence of bridging effects ensures stability. To control seepage of water a simple method is to sink wells and intensively pumpout water. So that the water table sinks below the level of the tunnel. Grouting of fissures, joints and faults, filling up of depressions in cavities and constructing a network of drainage controls majority problems of tunnels.

15.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The main problems to road alignment is safety from hazards of mass movement along the hill slopes and ground subsidence along the plains.
2. The debris is useful to construct parapet walls to control accidents, the material is useful to develop playing grounds, gardens and parking places along the road side.
3. The measures for stabilising the walls of road cuts are dewatering and drainage, reinforcement of slopes, afforestation and slope modifications.
4. The principle concern of engineering geologist involves in planning of a tunnel is the location of structural discontinuties and defects, lithological properties of rocks and seepage of water.
5. To minimise the problem of seepage in tunnels a simple method is to sink wells and intensively pumpout water until the water table sinks below the level of tunnel.

15.9. MODEL EXAMINATION QUESTIONS

I. Write your answer in about 30 lines.

1. How route alignment of roads and canals will do.
2. What the environmental problems, remedies of roads and canals.

II. Write your answer in about 10 lines.

1. What are the environmental problems of tunnels.
2. What are the extra problems of canals than roads, Explain.

Dr. P. Madhusudhana Reddy

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UNIT-16: SOIL - TYPES, EROSION AND CONSERVATION

Contents

16.1. Objectives
16.2. Introduction
16.3. Nature of Soil
16.4. Soil Profile
16.5. Geological Classification of Soil
16.6. Classification of Indian Soil
16.7. Soil erosion
16.8. Prevention and Control of Soil Erosion
16.9. Summary
16.10. Check Your Progress : Model Answers
16.11. Model Examination Questions

16.1. OBJECTIVES

After studying this unit, you should be able to:

* explain the definition and nature of soil,
* describe the soil profile, classification of soil in general and Indian soils in particular,
* explain the soil erosion - Prevention and control measures.

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16.2. INTRODUCTION

The soil is one of the most precious resources of the earth. It supports the life and civilization, providing food,fodder, fuel & fibre. Hence it is considered as the imperishable store-house eternity.

The healthy growth of plants generally depends upon the type of soil, availability of water and nutrients. In view of this, the awareness of soil types is increased in recent years to achieve high yield. Therefore, it is essential to understand the nature of soil, types of soil and the influence of soils on environment.

The rapid accumulation of knowledge in the recent years on soil has created a need for a separate branch named pedology. The word derived from greek('Pedo' means soil and logos means study) which means a systematic study of soil science. The soil has defined variously due to its multiple utilities.

The geologists considered soil as a product of weathering and it has been derived from minerals, rocks and contains decomposed remains of plant and animals. The soil scientists will say that soil is the weathered surface layer of the earth's crust which has been altered by the influence of water, air, organic matter and living organisms, Agronomists say that soil is the mixture of sand, clay, lime and humus which serves as a medium for plant growth. In brief, the soil may be defined as unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by

genetic and environmental factors viz., parent material, climate(including moisture and temperature effects), macro and micro organisms and topography, all acting over a period of time and producing a product - **soil**. It differs from material from which it is derived in many physical, chemical and biological properties and characteristics (source) : Glossary of soil science, Soil Science Society of America, 1979).

16.3. NATURE OF SOIL

There is a close relationship exists from ancient civilization to the present human life that exists on the earth. Even today most of the world's population are tillers of the soil and live close to the soil because of its importance. Thus soil is integrally and intimately connected with rocks beneath, the vegetation growing above and the water percolating through it. In other words it has its micro-climate wherein the vegetation growing above and the water percolating through it.

Soil consists of products of weathering of rocks, intermixed with living organisms and the products of their decay, the moisture and air filling the interstitial space. In other words the soil has a micro-climate of its own, controlled by water, air and organisms. The silt particles constitute the frame work and the clays and organic mater(humus) hold together the frame work serving as the nutrient base. The colloidal clays and humus will have the capacity for cation exchange and attract the molecules of water which form a sort of atmosphere around the clay particles. It is water attracting and water holding capabilities of the colloidal humus and clays that keep the soil moist even during the dry seasons. Thus the soil is living system and is endowed with an internal micro-atmosphere of air and vapour and is capable of supporting vegetation and promoting various biological and biochemical process.

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Geologists are considered that the soil as the upper part of the weathered material(regolith) resting on the bed rock and contain inorganic and organic nutrients. But the environmentalists say that soil is a dynamic living layer forming the foundation of all ecosystem. The farmers and horticulturists etc. are dependents upon soil and are more concerned with the primary production systems. It not only sustains and nourishes the primary production but also acts as a passage and store for groundwater which is essential for survival after cessation of rainfall.

There are two major categories of soils viz., Insitu or zonal soil and drift or azonal soil .The former category usually occur in relatively flat or undulating areas which are found as a result of weathering. The second category of soils are formed over the colluvial(emplaced by mass-movement) or alluvial(river borne) deposits also referred to as transported soils.

Check Your Progress 1 & 2

1. Define what is soil ?
2. Write the different categories of soil ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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16.4. SOIL PROFILE

During the development of soil from a given parent material, the actual transformation proceeds through certain recognisable stages. In any section of the soil, these stages may appear as a series of zones with contrasting properties. Such zones that are arranged in descending order and that indicate different stages in the development of soil are collectively referred as a **soil profile.**

The Soil profile is composed of three zones(from surface to downward) viz., A-Horizon or top soil B-Horizon and C-Horizon(fig.16.1)

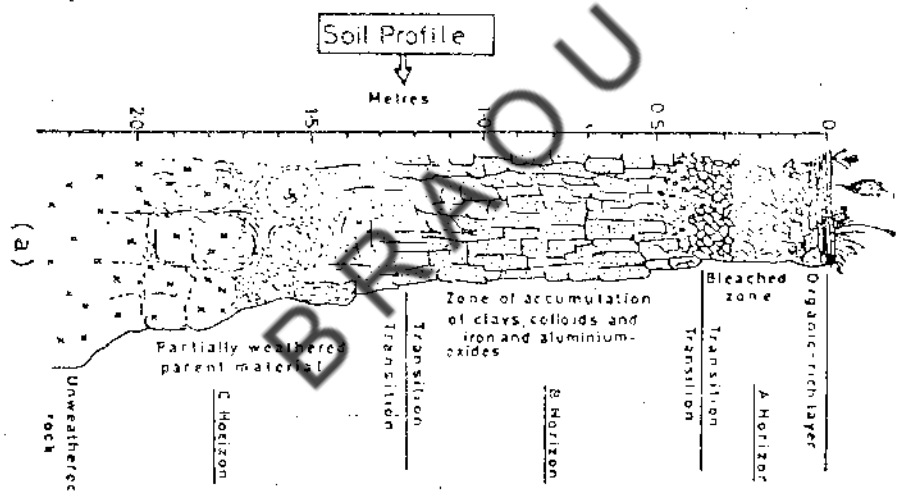

Fig. 16.1. Showing Soil Profile. (Source : Strahler, 1973)

1. A - Horizon

The upper most part of the soil is known as the top soil or A-Horizon. It is generally characteised by finely divided particles and extends from a few cms. to as much as one metre below the surface. The thickness of the top soil varies from place to place depending upon the composition of the parental bed rocks, topography, climate conditions, groundwater and the living environment.

The A-horizon support the life through its contends viz, humus, mineral nutrients, moisture and air. The top soil may further sub-divided into layers (A_1....A_2....A_n) on the basis of progressive stages of humification of contained organic matter.

2. B - Horizon

The B-Horizon lies immediately below A-Horizon. The thickness of B-Horizon varies

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from few cms to 1 metre . The zone composed of mineral rich soil in which organic matter occurs in small amount owing to its decomposition but is secondarily enriched in solute material(leaching down from A-Horizon).

3. C - Horizon

It is the basal zone characterised by coarse grained, rather pebbly texture. Practically it makes a transition zone between the actual solid rock and the finely decomposed rock.

In the Himalayan region the steeper slopes (more than 30^0) have usually a very thin cover of soil without evidence of maturity and commonly highly leached out and less productive.

16.5. GEOLOGICAL CLASSIFICATION OF SOILS

A number of classification have been suggested by various workers for the soils of Indian sub-continent. The existing different classifications differ from one another because of its multiple utilities in different branches of Science and Engineering. Keeping in view of, the geological classification is dealt in this unit.

There are two major classes of soils viz, residual soils and transported soils (Fig. 16.2). Those are described in detail and is given below.

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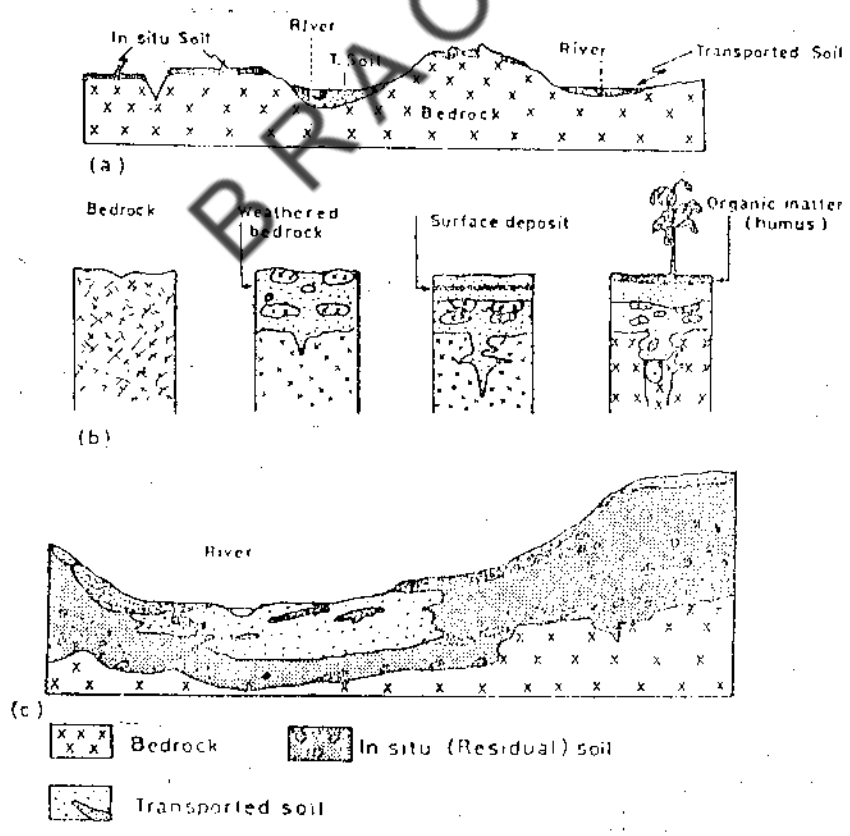

Fig. 16.2. Showing the situation and development of in situ (a & b) and transported soils (c). (Source : Marsh and Dozier, 1981)

1. Residual soils

These soils have suffered very little or no transport during or after their formation and are found more or less covering the parents rocks. The characteristics of the residual soils are described in brief.

A . Thickness : The thickness of residual soil varies from place to place based on the climate, lithology and the processes related to soil formation. Deep residual soils may be due to either rapid rate of soil formation or to the prolongation of the soil forming processes over long span of time.

B. Stratification : Residual soils generally show no stratification.

C. Chemical composition : The chemical composition of residual soil is defined principally by the nature of the parent rocks. The soils derived from granites, gabbros, basalts and impure limestone contain salts of K,Na and Al etc., that could not be leachedout during the process of rock decay, The residual soils are often rich in humus.

D. Leaching : The residnal soils are subjected to little leaching. Red and black soils of India are the best examples for residual soils.

2. Transported soils

The transported soils are those soils that have been deposited for away from the parent rocks . They are generally heterogencous in nature and makes it difficult to infer the source materials to study the individual soil types in the given region for selection of plant types for commercial production.

On the basis of transporting agent, the transported soils are classified into the following types.

i) Colluvial soils : There soils are formed under the influence of gravity and have moved for short distances from parent rocks. These soils commonly occur at or near the base of the slopes and are not well stratified.

ii) Alluvial soils : These soils are formed by the transporting agent of water in the form of streams and rivers. The food plain regions are generally dominated by these type of soils. The Indo-Gangetic Alluvium of India is the classic example for alluvial soils.

iii) Glacial soils : There soils are formed by the natural agents of erosion and deposition under the influence of glaciers. Such type of soils are dominated by the Himalayan soils and are heterogeneous in nature.

iv) Lacustraine soils : These soils are owe their origin to lakes and are generally very fertile. Vegetable matter is found good in abundance and exhibit stratification.

v) Eolian Soils : These soils are formed under the influence of wind and as a result the sand and dust particles transported to far away places and deposited. The wind deposited soils are composed mainly of silt and clay fractions. The arid and semi-arid regions of Northwest India are the classic examples for eolian soils.

Check Your Progress 3 & 4

3. Define the residual soil ?

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4. What is transports soil ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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16.6. CLASSIFICATION OF INDIAN SOILS

A number of classification have been suggested for the soils of Indian sub continent. The Indian soils are classified into five major classes viz., the red soils, the black soils, the Indo-Gangetic alluvium, the lateristic soils and miscellaneous soils which includes chiefly of forest and hill soils, alkaline, saline and desert soils. These soils are described below.

1. The Red soils

These soils have been formed due to decomposition of ancient crystalline rocks like granites and gneisses. The red soils are derived from rock type which have rich in iron and magnesium bearing minerals. The name red soil is due to provenlance of iron oxide. The red soils are generally poor in nitrogen,phosphores and humus but are rich in potash. The clay fraction of these soils consists of kaolinite minerals. Generally the red soils are deficient in soluble exchangeable bases.

The red soils are generally distributed in parts of Madras, Mysore, Southeast of Bombay, east of Hyderabad, Madhya Pradesh and Orissa. Further in parts of Bihar, Bengal and Uttar Pradesh.

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2. Black Soils

These soils are fine grained and were derived by decomposition and decay of basalts and ferrugeneous schists and gneisses. The behavior towards the moisture content is the characteristic feature of these soils. It becomes exceedingly sticky when wet and undergo considerable contraction on day. Owing to this, the properly of swelling and shrinkage will be noteworthy feature of these soils. The black soils consists of high quantities of iron, aluminum and magnesia, whereas phosphorous, nitrogen and organic matter is in poor percentage. The base exchange capacity of the black soils are fairly high. The black soils have been distributed widely in Bombay, western part of Madhya Pradesh, part of Gujarat and in some parts of Tamil Nadu and Andhra Pradesh.

3. Indo-Gangetic Alluvial Soils:

These are referred as alluvial soils. This type of soils cover the largest of all the soil groups of India. The alluvial soils have been divided into two types on the basis kankar concentration viz., Khadar and Bhangar soils respectively.

The most of Indo-Gangetic alluvium is spread over in northernstates of India and also Assam, Bengal, Bihar, Bombay, Tamil Nadu, Andhra Pradesh.

i. Khadar Soils : These soils are light in colour, less kankary and more siliceous in composition. It is composed of newer deposits.

ii. Bangar Soils : These soils are drak in colour with high kankar concentration They are more in cayey composition and are older alluvial deposits.

4. Lateritic Soils

These soils are formed as a result of decay of many types of rocks. There is a much controversy among the soil scientists with regards to its origion,However, the prevailing view of many soil scientists for the lateristic soils is the loss of silica from the soil profile occurs and enrichment of hyderated oxide of Alumina results under warm, humid and monsonic conditions. Such process is referred as laterisation and the resultant soils are known as lateritic soils. Laterite is a kind of vesicular rock composed essentially of mixutre of hydrated oxides of aluminum and iron with small percentages of oxides of manganese and titanium. These soils are spread over mainly in the hills of Deccan,Mysore, Kerala, Madhya pradesh, Orissa and Assam. Further the lateritic soils also developed along coast of Tamil Nadu at Ratnagiri and Kanara of Bombay. Shimoga, and Hassan districts of Karnataka.

5. Miscellaneous Soils

In addition to the major group of soils, other types of soils are recognised in india. These soils are viz., the forest and hill soils; the desert soils; saline and alkaline soils;and the peaty and marshy soils. These soil types are groups under miscellaneous soils

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i. Forest and Hill Soils : These soils occur along the mountain slopes and valleys in forest regions. The mode of formation of these soils are generally controlled by the factors like geology, topography, climate and vegetation of the mountain ranges. These soils show high content of organic matter and nitrogen. They show a great variation in their chemical and mechanical composition. The forest and hill soils are well developed in Punjab, Himachal Pradesh, eastern and western ghats, Jammu & Kashmir and in tarai regions of Uttar pradesh. But in tarai regions, these soils show unhealthy conditions attributable possible due to excessive soil moisture and high growth of vegetation.

ii. Desert Soils : A large part of desert soils are distributed in the Gujarat and Rajasthan of north-western India covering an area of about 40,000 square miles because of scarcity of water and in barren lands without any vegetation cover. Recently the R & D studies were initiated by Government of India to study the desertification and their remedial measure. These studies have high lighted that the Haryana and part of Delhi would become desert due to the sand migration from the Thar desert by the influence of wind. Keeping in view of this threat, the government of India in collaboration with Japan together with Aghakhan foundation and other international volunteer organisation started plantations in Arvalli and Trans-Aravalli mountains. The barren lands of these desert is slow changing to .green belt so as to stop sand migration to adjacent stages of india.

iii. Saline and Alkaline Soils : The saline soils are the salt impregnated soils. The characteristics of these soils is that they contain undecomposed mineral fragments which is on weathering liberate sodium, magnesium and calcium salts. These salts are confined to the top layers and their concentration is limited to the upper parts of the soil layers due to capillary action. These injurious salts (reh soils) always damage the fertility of the soil and their concentration has created a major problem for the country. The alkaline soils are developed mainly due to canal irrigation by which it is contributed towards the increase in soil alkalinity. It is estimated that about 2 lakhs acres in Uttar Pradesh ad about 5 lakh acres of land in Panjab are under the influence of reh salts. The remedial measures are that the growth of salt resistant crops like rice and sugarcane.

iv. Peaty and Marshy Soils : The peaty soils are developed in some parts of Kerala. They are organic soils and rich in soluble salts. They are generally acidic and black in color. The marshy soils are developed in depressions formed by dried river basins and lakes in coastal areas. These soils are rich in ferrous salts and hence it appears in bluish color. These soils are generally developed along the coastal tracts of Orissa and in Sunderbans of Bengal.

Check Your Progress 5 & 6

7. How the red soils are formed ?
8. How black soils are formed ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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16.7. SOIL EROSION

The soil erosion is one of the environmental hazard in recent years by which it looses its fertility and converts into deserts. The adverse affects of drastic micro-climatic change is due to deprivation of vegetation cover. The human activity lead to destroy the green cover as seen in Himalaya and Niligiri hills. The increased degration lead to soil erosion and clearly visible in the form of sediments transported by the rivers. The national and International volunteer organisation together with the ministry of environment are trying to put control soil erosion in order to safeguard the soil fertility in the farm aggravation in the hill regions where in drought resistant (xerophytic) plants tolerant to dryness have taken a hold of the deforested slopes in the mountain regions. These will rapidly be replacing by the local flora on the eroded soil regious. Example Kosi Valley of the Lesser Himalayan terrain in Kumaun and Garhwar sector of

Himalaya. Soil erosion occurs naturally and also by human activity. The natural erosion takes place by sheet erosion and gully erosion and is deseribed below.

1. Sheet erosion

Uniform skimming of top soil will take place by the sheet erosion. The soil grains are separated and made free to float away during the initial stages of rainfall, and an amount of water flowing downwards exceeds the soil grains are carried downwards. This process starts simultaneously over a large area during the rainy season and huge thin sheet area eroded away in the form of loose soil grains are carried downslopes along with the water.

2. Gully erosion

The soil surface is not uniform but slightly depressed and is known as gullying. Thus the slightly depressed area in the field eventually get much eroded in the gullies of varying depth and extent during the rainly season and is carried away the loose soil materials.

16.8. PREVENTION AND CONTROL OF SOIL EROSION

The control measures so far available for soil erosion fall under two heads, viz., agronomic methods and engineering methods.

1. Agronomic practice

The protection of the top soil by special methods and schemes of crop cultivation. This has been proved successful in many cases and these are described below.

a) Crop-rotation : Different crops are grown in the same field according to a definite scheme of rotation i.e. one after another. A sequence commonly followed, for instance, is a cultivated crop, a small grain and then grass(after which again cultivated crop will be grown).

b) Strip croping : In which cultivated crops and the cover crops are shown in alternate strips. These strips are generally made parallel with the contours.

2 . Engineering methods

The engineering methods are most widely used for combating soil erosion which include the following

a) Excavation of different types of ditches for the removal of excessive water from the fields

b) Construction of suitable types of terraces

c) Construction of dams for checking the soil erosion .

Check Your Progress 7 & 8

9) What is gully erosion ?

10) Mention any two types of the soil erosion control measures ?

Note : (a) Write your answers in the space given below.

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(b) Compare your answers with the model answers given at the end of this unit.

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6.9. SUMMARY

Soil is the imperishable store house of enternity which supports life, civilisation, food and shelter to the man. The soil is the living system which is endowed with an internal micro-climate and is capable of supporting vegetation and promoting various bilogical and biochemical process. The soil profile is composed of A-horizon, B-horizon, C-horizon respectively in the ascending order of aniquity from surface to the down wards. A-horizon is characterised by finc particles which extends from few cms to 1 m below the surface. It supports the plant life through its mineral constituents. The B-horizon lies immediately below the A-horizon and is composed of mineral rich soil. The C-horizon lies below the B-horizon and is characterised by a coarse grained and pebbly texture.

The soil have been classified into residual and transported soils on the basis of geology. The residual soils have suffered little to no transportation on the other hand the tranported soils have been deposited far away from its sourse and is divided into colluvial, alluvial, glacial, laustrine and eolian soils. On the basis of distribution of different soils in India, the Indian soils have been classified into five major classes namely red soils, black soils,Indo-Gangetic alluvial soils, lateritic and miscellaneous soils. The miscellaneous soils are further sub divided into forest & hill, alkaline & saline, desert, peaty and marshy soils.

The increased deforestation in recent years have posed environmental hazard by which it loses it fertility and converts to desert land. The soil erosion is generally achieved by artificial and by natural processes. The natural soil erosion will take place either due to sheet erosion or by gully erosion. In order to prevent soil erosion, the deforestation should be stopped. Further crop rotation, trip cropping and engineering techniques should be implimented in the field. These practices will lead to control soil erosion as a result the crop production yield also enhanced.

16.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Soil may be defined as unconsolidated mineral matter on the surface of the earth that has been subjected to and influenced by genetic and environmental factors viz., parent material, climate, macro and micro organisms and topography all affecting over a period of time and prodducing a product - soil.

2. There are two major categories of soils. These are instiu or zonal soils and drift or azonal soil.

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3. The residual soils have suffered very little or no transport during or after their formation and are found more or less covering the parent rocks are referred as residual soils.

4. Transported soils are those soils that have been deposited far away from the parent rocks.

5. The red soils have been formed due to decompostion of ancient crystalline rocks like granites and gneisses. These soils are rich in iron and magnecium minerals.

6. The black soils were derived by decomposition and decay of basalts, furugeneous schists and gneisses. These soils consits of high amount of iron, alluminium and magnesium.

7. The soil surface is not uniform but slightly depressed and is known as gullying. Thus the slightly depressed areas in the field eventually get eroded in the gullies of varying depth and extent during the rainy season.

8. The control mesasures so far available for soil erosion will fall under two categories. They are 1) agronomic methods and 2) engineering methods

16.11. MODEL EXAMINATION QUESTION

I. Answer the following questions in about 30 lines each.

1. What is soil profile and describe the different horizons.
2. Describe the geological classification soils.
3. Explain the classification of Indias soils.
4. Write in detail the control measures of soil erosion.

II. Answer the following questions in about 10 lines each.

1. Explain the A-horizon in the soil profile.
2. What is colluvial soil.
3. What is lacustrine soil.
4. What is miscellaneous soil.
5. Write the soil erosion control measures related to engineering methods.

Dr. M. Jafaruddin

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UNIT-17: REMOTE SENSING - ENVIRONMENT

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17.1. OBJECTIVES

After going through this unit, you will be able to :

* explain the fundamental properties of Remote Sensing interms of electro-magnetic radiation(EMR) and its interactions with the atmosphere and the surface features,
* describe the contemporary satellites and sensors of different countries in the world programs,
* explain the use of satellite data in different disciplines.

17.2. INTRODUCTION

The remote sensing is one of the spillover technology of the space research of 21st century. It ushered a new era in the history of mankind and opened a new avenues for the human endeavour. It is a time and cost effective technology interms of its multiple applications in many disciplines. For example, deforestation vis-a-vis afforestation,the after effects and damage estimation due to earthquakes, landslides, volcanic eruptions, and floods; and environmental impact assessment etc., can be carriedout besides many applications by the satellite derived remote sensing data.

The remote sensing data is available in the form of imageries and the digital data in computer compatable tapes(CCT's) Accordingly the interpretation of these data falls under two categories viz., visual and digital data processing. The term Remote Sensing is defined as the art of deriving information about an object or an area without in touch with it. It means that this interpretation of any region, can be made by the satellite data at a distance form it. For example, the effect of damage due to floods in coastal area of Andhra Pradesh can be carriedout without in touch with it.

In order to understand the Remote Sensing,it is essential to have a brief knowledge about the fundamentals of remote sensing interms of detection of objects on the earth surface by sensors placed in the payload.

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17.3. FUNDAMENTALS OF REMOTE SENSING

In order to understand the fundamentals of remote sensing it is essential to understand the principles of physics interms of generation and propagation of electromagnetic spectrum.

17.3.1. Electromagnetic (EM) Spectrum

Visible light is the only one of many forms of electromagnetic energy. Radio waves, heat, x-rays, and other familiar forms.All this energy is inheritantly similar and radiates in accordance with basic principles wave theory.This theory described electromagnetic energy propagations in a harmonic, sinusoidal fashion (Fig.17.1) at the velocity of light(C). The distance from one wave peak to the next is wave length (λ) and the number of peaks passing a fixed point in space per unit time is the wave frephency (f). The **wave theory** obey the following equation.

$$C = f\lambda \quad \text{_____} \quad (1)$$

where C = constant(3×10^8 m/sec)

In remote sensing, it is most common to categorise EM waves by their wave length location with EM spectrum.The unit used to measure wave length along the spectrum is the micro-meter(μm).A micro meter equals to 1×10^{-6} m.

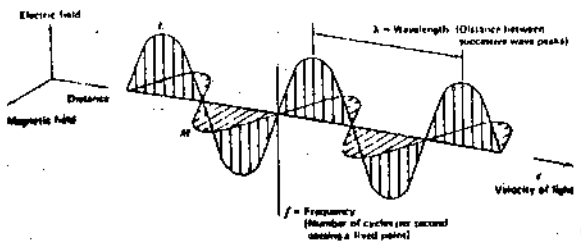

Fig. 17.1. Showing electromagnetic wave propogation

For our convenience, EM spectrum is assigned into different regions but no clear cut dividing line between one region to the next. It should be noted that the portions of EM spectrum used in remote sensing lie along a continum characterised by magnitude changes of many powers of 10. The visible portion of EM spectrum is very small and it extends from about 0.4 to 0.7 μm. To the right side of the visible range lies reflected, infra-red, thermal infrared, microwave, television and radio-waves. On the other hand, to the left of the EM spectrum lies visible range lie ultra-violet, x-rays, γ-rays and cosmic rays (Fig 17.2) The important distinction between reflected infrared and thermal infrared energy is that the thermal infrared energy is directly related to the sensation of heat but reflected infrared is not so.

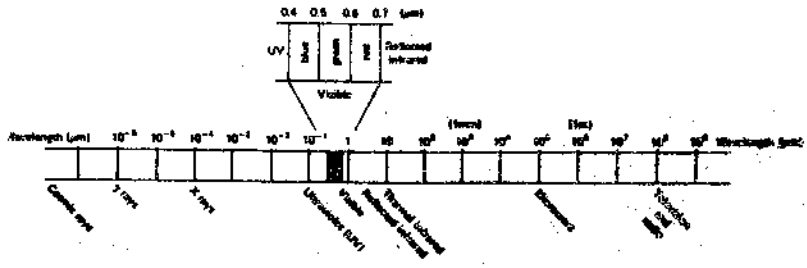

Fig. 17.2. Showing the electromagnetic spectrum.

In EM spectrum, another theory generally used to provide useful insights about EM energy is the interaction of matter.This theory known as particle theory. It suggests that EMR is comprises of theory known as **particle theory.** It suggests that EMR is comprises of may descrete units called photons, or quanta and is expressed as

$$E = hf \quad \text{_____} \quad (2)$$

where E = Energy of a quantum, Joules(J)

h = planck's constant (6.626×10^{-34} J sec)

By relating the wave theory expression(1) and particle theory expression(2) and by substituting equation (1) into equation (2) the following is obtained

$$E = hc / \lambda$$

The above equation demonstrates that the energy of a quantum is inversely proportional to its wave length. The longer the wave length involved, the lower the energy content. The important application in remote sensing point of view is that the naturally emitted long wave length radiation (micro-wave emissions) of terrain features is more difficult to sense, than the radiation in shorter wave lengths (thermal, and infra-red etc.,)

17.3.2. Generation of Electromagnetic Radiation (EMR)

The EMR is generated whenever the size or direction of an electric or magnetic field fluctuates with time. The γ-rays radiation resulting due to disruption of atomic nuclei during nuclear fission or fusion and have shortest wave lengths in the electromagnetic spectrum. The x-rays, ultra-violet and visible range radiation is resulting in due to electron-shifts of the particles. The infrared and micro-wave radiation is resulting due to vibration and rotation of molicules.

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In nature all of these processes are related to temperature of emitting radiation which is generally above the absolute zero(-273.15^{0}C) The 0^{0}C is expressed as 273.15 K(Kelvin). Matter is capable of absorbing and remitting all EM energy which it receives is called **black-body.** The total energy emitted by a black body is expressed as given below and it is known as **Stefan-Boltzman law.**

$$H = \sigma T^4$$

Where

H = Total emittance of radiation per unit Wm^{-2}

T = absolute temperature

σ = Stefan-Boltzman constant(5.7×10^{-8} Wm^{-2},K^{-4})

At any particular temperature, a black-body emits EMR with a range of wave lenghts. However, its absolute temperature determines which wave length transmits the maximum energy and is expressed by Wein's displacement law and is given as below.

$$\lambda_m = 2898/T$$

where λ_m = dominant wave length

T = Temperature

The wein's displacement law suggests that as the temperature increases, the total energy emitted rises rapidly and the wave lengths carrying becomes shorter. Thus a black body at 6000K, the surface temperature of the sun does not emit radiation with wave lengths shorter than 0.1μm (Fig.17.3)

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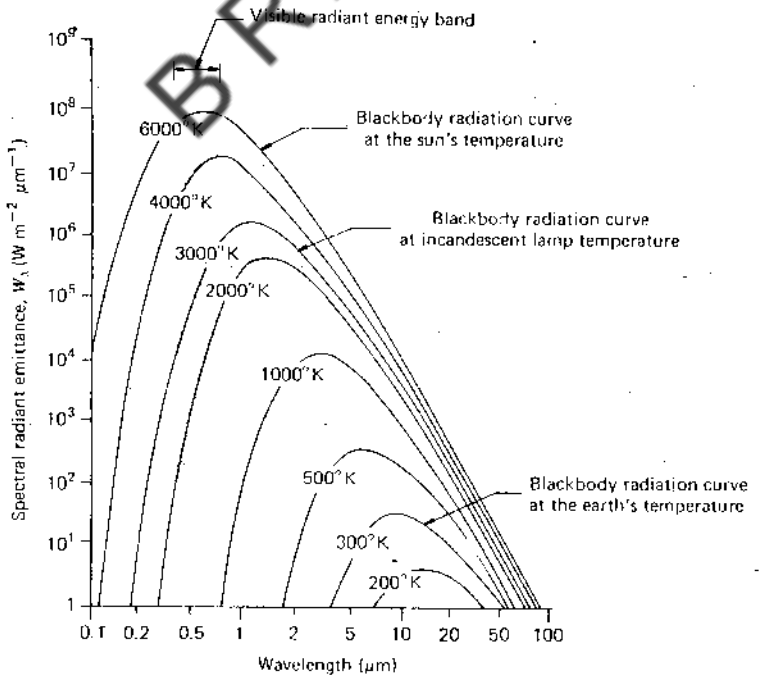

Fig. 17.3. Showing spectral distribution of energy radiated from balck-bodies at various temperatures.

The remote sensing deals with two types of radiation.The earth's surface receives the radiation from sun is absorbed or reflected is emitted by the surface is detected but the sensors is referred as **passive remote sensing systems**. On the other hand, the artificial energy employed and is detected by sensors is referred to as **active remote sensing systems**. Example Radar (Radio Detecting and Ranging).

17.3.3. EMR Interaction in the Atmosphere

The whole range of EM spectrum is available to the remote sensing detectors but only a few bands will be detected due to atmospheric effects. These radiations has to pass through the atmosphere and then back to the sensors mounted in the satellite.These effects are caused atmospheric scattering and absorption.

Many remote sensing sensors are generally does not shows the coverage of blue sky. This is caused by one of a number of phenomena resulting from diffusion of radiation is called **scattering**. When EMR interacts with particles smaller than its wave length, then the degree of scattering is inversely proportional to the fourth power of wave length and is known as **rayleight scattering**. Example molicules of oxygen and nitrogen etc. Because of this reason, many sensors omit the coverage of blue sky in remote sensing. The same can be achieved in panchromatic images using yellow filter. When the atmospheric particles are similar size to the wave length of incoming radiation is called **mie-scattering.** Example - molicules of water and dust. The atmospheric absorption results in the effective loss of energy to atmospheric constituents. The main absorption of solar radiation is this regard are water vapour, carbon-dioxide and ozone. The absorbance of EM energy in the atmosphere is restricted to specific wave length bands. The wave bands that passes relatively undiminished through the atmosphere is referred to as **atmospheric windows**. The emitted heat energy from the earth is sensed through the atmospheric windows at 3 to 5 μm and 8-14 μm.The multispectral scanners sense simultaneously at various wave length bands in the visible through thermal spectral scanners.On the other hand, Radar is operated through a window in the range of 1 m.m to 1metre.

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17.3.4. EMR Interaction with Surface Features on the Earth

The energy detected by remote sensing over a spectrum of EMR is partitioned between its source and the materials with which it interacts on its way to the detector (sensor). There are three kinds of spectra can be measured for any material. These are 1)absorption 2) reflection and 3) emissions. An absorption or transmission spectrum is produced when the materials is interposed between source and sensor.A reflected spectrum is measured when both the source and the detector is on the same side of the material.Lastly the material itself is the source for the emission spectrum.Applying the principle of conservation of energy the interrelationship of these three energy interaction as

Where

$$E_I = E_R\lambda + E_A\lambda + E_T^1\lambda$$

where

E_I = Incident energy

E_R = Reflected energy

E_T = Transmitted Energy

In the above cited energy balance equation, the energy reflected, absorbed and transmitted will vary for different features depending upon the material type and condition. Further, the different wave length bands depends on the basis of the surface features.

In the remote sensing systems, the reflected energy predominates so its reflectance properties of the earth features are very important.Hence the energy balance relationship is expressed as below.

$$E_R(\lambda) = I_I\lambda - [E_A\lambda + E_T\lambda]$$

The energy reflectance of an object is important to be considered and this factor is generally depend upon the surface roughness of the object. In the case of flat surfaces, the reflectors are mirror like where the angle of reflection equals to the angle of incidence is called specular reflectors. On the other hand, in the case of rough surface the reflectors are uniformly in all directions and is referred to as diffuse (lambertion) reflectors.But in nature, the reflectors of the objects on the earth surfaces are generally neither specular nor diffuse but are in between the two extremes. These are known as **near perfect specular and near-perfect diffuse reflectors**. The characteristic feature of the diffuse reflectors is that it pocesses spectral information but specular reflectors do not have such property.

The reflectance characteristics of the earth surface features on the earth may be calculated by measuring the portion of incident energy that is reflected which is a function of wave length is called specular reflectance(λ_R). It is mathematically expressed as

$$R_\lambda = \frac{E_R(\lambda)}{E_I(\lambda)} \times 100$$

where R_λ is expressed as percentage

The spectral reflectance curve varies for different objects. The special reflectance of vegitation soil and water is shown in Fig.17.4.

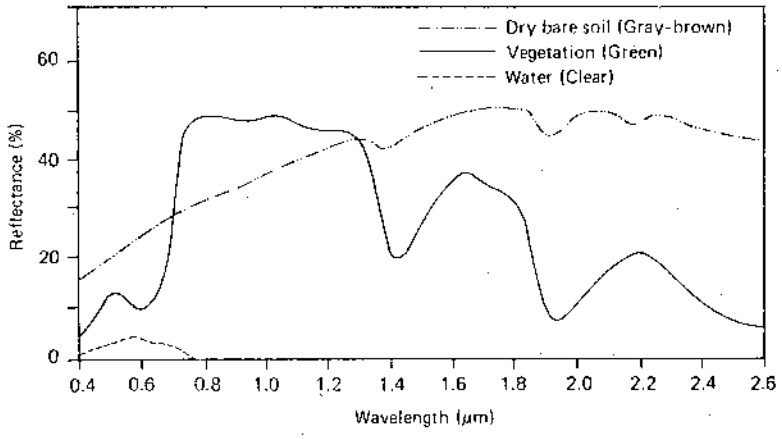

Fig. 17.4. Showing spectral reflection curve.

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Check Your Progress 1&2

1. Define What is Remote Sensing ?
2. What is atmospheric windows ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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17.4. REMOTE SENSING SATELLITES AND SENSORS

There are many satellites have been launched into space by different countries and each satellite data vary from one another by their resolution and other features. The increased use of satelllite data in recent years have made necessary to know about these contemporary satellites and its features.The sensor means that it is a device that receives EMR and converts into a signal that can be recorded and displayed as either in numerical data or an image.The following sections will provide an over view of major contemporary satellites, its sensors, resolution, and other features.

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17.4.1. Indian Remote Sensing Satellite (IRS)

The IRS-IA has launched into space on 17th March, 1988 which has made a milestone in the history of remote sensing in the country. The second in the series,IRS-IB launched on 29th August, 1991 and the IRS-IC launched very recently in 1996.

The IRS-IA/IB satellite have nominal altitude of 904 kms. and orbital inclination of 99° which makes them nearly polar. They are in a sun synchronous orbit which means that the orbit plane moves from west to east at about same angular rate that the earth moves around the sun.This enables the spaces craft to cross the equator at the local time of 10.00 to 10.30 A.M. Every day the orbital period is about 103 minutes and the satellite completes 14 orbits per day. It takes 22 days to complete one cycle of the globe in 308 minutes. The payland consists of two imaging sensors called Linear Imaging and Self Scanning (LISS) sensors. The LISS-I has resolution of 72.5 m.while LISS-II have a resolution of 36.25 M.

The polar Satellite Launch Vehicle (PSLV) named as IRS-P_2 satellite have launched in the polar orbit on 15thOctober, 1994. It carried LISS-II sensor camera with a resolution of 37.39 M (along track) and 32.74M (Across-track) with a total swath of 130 Kms.

The IRS-P_3 developed by India as a part of space programme on thePSLV(PSLV-P_3). It comprises of x-rays astronomy payload and remote sensing pay load namely wide field sensor (WiFS) and Modular Opto-electronics Scanner (MOS). This satellite data is applicable to oceanographic studies.

The IRS-IC have three types of imaging sensors namely

1. Panchromatic Camera (Pan) is being designed to provide data with a spatial resolution of 58 m. and a ground swath of 70 Kms.
2. LISS-III provide multispectral data in visible, near infrared and short wave infra-red regions of EM spectrum. The spatial resolution and swath in visible and wave near IR regions are 23.5 m and 141 km and 70.5 M and 148 Km respectively.
3. Wide Field Sensor(WiFS) collects in two spectral bands is visible and near IR regions and has ground swath of 770 kms with a spatial resolution of 188 M.

17.4.2. American Remote Sensing Satellite

United States of America has launched a series of satellites called LANDSAT series. The first satellite in this series was named as Earth Resources Technology Satellite(ERTS-1) and is latter renamed as Landsat-1.It was launched in July, 1972 at an altitude of 920 kms and the payload comprises of two sensors namely Return Beam Videocon (RBV) and Multi Spectral Scanner (MSS). These sensors capture images of the earth in different spectral bands ranging from visible to near infrared region of EM spectrum

Landsat-2 and 3 were launched in 1975 and 1978 respectively. The landsat 4 and 5 were launched in 1982 and 1984 respectively. It takes about 99 minutes and completes 14.5 orbits per day, covering the entire earth in every sixteen days.The resolution of RBV sensor is 79M, MSS is 80 M and Thematic Mapper (TM) resolution is 30 M.The TM Band-6 ground resolution is 120 M and the swath is 185 Km. for all these sensors.

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17.4.3. European Remote Sensing Satellite (ERS-1)

The first operational micro-wave remote sensing satellite developed by European Space Agency (ESA) was launched on 17th July, 1991. It provide observation of global data on environment using advanced micro wave techniques which enable to made measurements even under cloudy conditions and during night also. The ERS-I is a sun-synchronous, near polar orbit at an altitude of 785 Kms with an inclination of 98.5^0. The time for one orbit is about 100 minutes and it consists of active & passive sensors. These are as follows

a) Active microwave instruments (AMI) : It consists of two separate radars namely Synthetic Aperture Radar (SAR) and wind scatterometer. There are three modes of operation of AMI namely image mode, wave mode and wind mode.

b) Radar Altimeter (RA) : It provides measurements of altitude, wave height, surface wind over the ocean, mesoscale topographic data such as ocean currents, coast lines, sea bed features and various parameters over sea ice and ice sheets, land surface elevations, elevation on lakes, mashes and rivers can be obtained.

c) Micro wave sounder (MWS) : This is a passive two channel experimental radio meter and provides information on total precipitation, and total liquid water content of the atmosphere.

d) Along Track scanning Radiometer (ATSR) : This is a four channel experimental infrared imaging radiometer which enables for accurate measments of sea surface and cloud top temperature.

e) Laser Retroreflector (LR) : This enables ranging of the satellite by the use of ground based laser tracking stations to determine the precise orbit and calibration data in support of altimeter mission.

17.4.4. France Remote Sensing Satellite (SPOT)

The satellite developed by the scientists of France named SPOT-1 and SPOT-2 it was launched in February 1987 and 1990 respectively. The SPOT 1/2 satellites maintain a near polar, sun-synchronous orbit at an altitude of about 813 km with an inclination of 98.6^0. The payload of SPOT consists of two high resolution visible (HRV) cameras with a ground resolution of 20 m and in panchromatic mode data collected in a broad single spectral band with a ground resolution of 10M.

There are two type of viewing methods with HRV cameras

a) Nadir viewing : The two cameras of HRV pointed vertically wherein the swath width is 116 kms with an overlap of 4 kms.

b) Off radir view : In this mode the SPOT satellite have the HRV cameras. Here it is possible to observe any region of interest within at 950 kms. widestrip centred on the satellite ground track. The width of the swath varies between 60 kms for vertical and 85 km for extreme lateral viewing. Another advantage in this is that stereo images can be obtained by which three dimensional viewing of any terrain may be possible.

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17.4.5. Environmental Satellite

The National Oceanic and Administration is (NOAA) operational Polar orbiting Environmental Satellite (POES) system which is called the TIROS-N/NOAA . A series of these types have developed and launched into space.These satellites are in a near polar, sun synchronous orbit at an altitude of 833 kms. The orbital period is about 102 minutes which produces 14.1 orbit per day. Currently National Remote Sensing Agency (NRSA), Hyderabd acquiring data from NOAA-14 and has the archieved data from NOAA-11 and NOAA-12. The TIROS-N/NOAA series has four primary instruments namely Advanced Very High Resolution Radiometer(AVHRR), TIROS Operational Vertical Sounder (TOVS) Data Collection System (DCS) and Space Environment Monitor (SEM). The NOAA Satellite data stream consists of high bit and low bit data. The TIROS Information Processor (TIP) is a low bit data processor. TIP consists of TOVS, SEM and DCS instruments. The AVHRR provides high bit data. The High Resolution Picture Transmission (HRPT) format is operational mode for broad costing. AVHRR data is of 1.1 km resolution together with TIP data.

17.4.6. Sea Star Satellite

The Sea Star satellite, developed by the orbital sciences corporation which is a U.S.Company. The satellite is a sun- synchronous orbit at an attitude of 705 km with

the equatorial crossing time at noon. The payland of Sea Star have sea-viewing wide field of view sensor (SeaWIFS) to map the Coastal Zone Color Scanner (CZCS). The principal objective of Sea WIFS is to acquire data to study the ocean interms of primary production in global biogeochemistry together with exchange of elements and gases between the atmosphere and ocean.

The Sea Star satellite transmits data in two bands namesly S-band and L-band. The S-band downlink is utilized to transmit stored Local Area Coverage (LAC) and Global Area Coverage(GAC) twice daily to Wallops Flight Facility (WFF). The L-band downlink transmits real time LAC data continuously for users.The resolution of the satellite is 1.1.km with a swath of 2801 kms for LAC data and the GAC data have a resolution of 4.5 km with a swatth of 1502 kms.

Check Your Progress 3 & 4

3. Define What is remote sensing sansor ?
4. How many types of sensors are present in IRS IA/IB and mention their resolution?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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17.5. APPLICATIONS OF REMOTE SENSING

The earlier interpretation of surface features on the earth was by study of areal photographs. But since the space technology improved and the different satellite data come to existence, the regional reconnaissance and detail studies have undertaken by remote sensing. It is a time and cost effective technology. The applications of data in different fields have increased in recent years which are described briefly in the following sub-sections.

17.5.1. Geological Remote Sensing

Photogeology can be defined as the visual extraction of geological information from a photograph or an image by conventional photo-interpretation instruments and techniques .The developments in space technology made wider applications resulted a new branch referred **geological remote sensing**. It comprises manual and digital analysis of images from remote sensing of passive and active systems. It covers a wide range of EM spectrum from the ultra-violet through visible, near infrared, thermal infra-red and to micro-wave region. Thus the geological remote sensing gives much emphasis on spectral analysis of digital images related to geological studies.

Geological mapping is essential to geologists to understand the geologic enigma. The LANDSAT images have widely used to such studies. Example : Zagros mountain Belt, of Iron, Saudi Arabian shield and Antarctica. The IRS data have used for geological mapping for Cuddapah basin and Aravalli mountain belt of India. Thematic interpretation providied by the satellite data enable to trace the macro, meso structures viz, faults, folds, crators, calderas, volcanoes and dykes etc. The interpreted structural features will provide a better knowledge on Structure and Tectonics of any mountain belt. Morphotectonics is the study of landforms of regional or tectonic significance using topography as a primary criteria in order to trace geologic structures aided by remote sensing techniques.

Satellite data applications in **mineral exploration**. Mineral resource discoveries have been made based on the use of landsat data. Example : Porphyry Copper deposit in western Pakistan;copper and Molybdenum deposits in Mexico and Uranium mineralisation in western Australia.

Applications of remote sensing will enable in search of **petroleum exploration**. The landsat-1 image mosaics of Texas and New Mexico have shown that a good correlation between surface lineaments vis-a-vis gas and oil fields.

The Radar images are used to study the geologic remote sensing in the thickly clouded and vegetated areas. In such areas namely Indonasia, Jawa, Sumitra and Iran, the regional tectonics studies enable to delineate oil and gas fields. In **coal exploration** also the satellite data is widely used. The Coal mine fires, mine collapses have best studied in Indian coal fields by IRS data. Such studies enable to save mineral wealth from sub-surface fires and remedial measures also be made in order to control the burning of coal mines.

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The thermal infrared protium of EM spectrum ranges from 3 to 5.5 μm and 8 to 14 μm of satellite data useful in **geothermal areas**. These studies enable to

1) Better understanding of volcanic and geothermal processes.

2) Hazard warning to determine possible explosion there by reducing the loss of human life by volcanic erruptions.

3) Geothermal exploration used to develop for power generation.

The remotely sensed data is applicable in **Engineering geology**. It is used to plan site investigations, terrain features together with geology and to integrate all thematic data for site selection for engineering projects.

The geologic hazardous studies, viz, seismic, landslides, volcanic, glacial, coal mine collapses, dam failures and floods are best studied by remote sensing.In addition to geologic remote sensing, the extra-terrestrial studies also possible by satellite data.

17.5.2. Applications in Land Use/Land Cover

The term land cover is concerned with the features present on the surface of the earth namely urban buildings, lakes, trees and glacial ice etc. The term land use relates to the human activity associated with a specific piece of land. For example, a tract of land on the fringe of an urban area may be used for residential, industrial, and garden, pavement etc.

The knowledge of land use and land cover is important for planning and management activities. The use of SPOT,IRS and high resolution satellite data together medium scale areal photographs are utilised for land use/ land cover mapping of large areas. These maps are very much important to study the socio-economic aspects of land use planning activities.

17.5.3. Applications in wet land studies

A wet land is defined as the land where the water table is at, near, or above the land surface, to promote the formation of hydric(wet) soils which support the growth of hydrophytes(plants that grow in water or very wet soil) The wet land mapping gained importance in recent years with satellite data. The The land maps will useful for variety of potential users including wildlife managers, hydrologists, landscape planers, economists, engineers and other public and private users.

17.5.4. Applications in Urban and Regional planning

Urban and regional planners require nearly continuous acquisition of data to formulate governmental policies and programs. These policies and programs range from socio-economic and cultural domain to the extent of environmental and natural resources planning.

The increased use of high resolution remote sensing data has provide upto date information in urban and regional planning such as estimation of population on the basis of residential complexes/houses, traffic and parking studies etc.

In addition to this, the environmental factors are also interpretable such as presence/ absence of garbage, industrial waste sites etc. Thus the urban and regional mapping can assist in various location and siting problems,such as transportation route location, sanitary land fill site selection, power plant siting location and transmission wire location. The same general decision making process is followed in each of these selection process.

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17.5.5. Applications in Agricultural Science

The remote sensing data is widely used in the field of agricultural science in recent years. The satellite data is mainly applicable in selected areas namely crop type classification, crop condition assessment and crop yield estimation and soil type studies.

Crop type classification is carriedout by satellite data with selected groundtruths. These interpretation is based on the spectral response pattern and photo-texture. Specific crop types can be identified in agricultural areas on the basis of high resolution panchromatic SPOT and IRS and other satellite date products.

Crop condition estimation also possible by satellite data which include crop disease, insect damage, plant stress from other causes and disaster damage. Lastly the crop yield estimation based on the remotely sensed interpretation has met with varying degree of success.

17.5.6. Applications in Forestry

The forestry is concerned with the management of forests and to maintain the existing greenery in order to maintain the fragile ecosystem., Tree species identification in the

given forest is more complex than agricultural crop identification. However the different plant species in the forest identified by the use of areal photograph with the satellite data. The remote sensing data is used in order to understand the percentage of existing forestry in the given region. Further aforestation vis-a-vis deforestation of any given region can be better studied aided by remote sensing data.

17.5.7. Applications in Wildlife Ecology

The term wildlife refers to animals that live in a wild, undomesticated state. The wildlife ecology deals with the interactions between wildlife and their environment. The related activities are wildlife conservation and wildlife management. The two aspects of wildlife ecology is namely, wildlife habitat mapping and wildlife sensing which are more important and can be studied by remote sensing data.

17.5.8. Applications in Water Resources

Water is one of the important resources to the mankind on the earth which will be used for irrigation, power generation, drinking, manufacturing industries and irrigation etc.

The satellite data is applicable in detecting the groundwater location, hydrologic watershed assessment, reservoir site selection, shoreline erosion and snow cover mapping etc.

The other important application of remote sensing and air photo interpretation are for water pollution detection, quality of lakes and flood damage estimation.

The water pollution detection means that natural sources of pollution include the minerals leached from soil and decaying vegetation and artificial sources of pollution include industrial effluents and domestic, sewage flowing to the near by rivers. The surface water pollutants can be detected by the satellite data, such studies were carriedout using landsat images example. Hussain Sagar pollution in Hyderabad is studied with the satellite data.

In flood damage estimation studies, the remote sensing data is widely applicable to assess the intencity of flood effected areas in the given region. This type of study, is a time and cost effective technology for better management in flood relief activities.

17.5.9. Applications in Archeology

Archeology is concerned with the scientific study of historic or prehistoric times by analysis of the remains of their existence, especially those remains that have been discovered through earth excavation.

Surface features, include visible ruins, mound, rock piles and other surface markings. Sometimes, the ruined buildings, and the past cultural heritage buried under the soil cover is studied by remote sensing data and by areal photograph interpretation. Under the areal photographs and satellite data interpretation total anomalies resulting from slight differences in soil moisture can be detected. These interpretations have proved success in delineation of hidden buildings, ditches, canals and roads by excavation. Thus the remotesensing application in archaeology is widely used by archeologists during their excavation programes.

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17.5.10.Applications in Environmental impacts Assessment(EIA)

The increased human activity on the land resulting in adverse environmental effects.Examples, include the construction and operation of high ways, rail roads, pipelines, air ports,industrial sites, power plants and transmission lines, sanitary landfill and radio active waste disposal operations, timber harvesting and strip mining operations.

The key items to be evaluated in an EIA are

1) The environmental impact of the proposed action.
2) Any adverse environmental effects that cannot be avoided.
3) Alternatives to the proposed action.
4) The relationship between local short term uses of the environment and the maintanence and enhancement of long term productivity.

Check Your Progress 6 & 7

5) What is geological remote sensing.
6) Write the remote sensing applications in different disciplines.

Note : (a) Write your answers in the space given below.
(b) Compare your answers with the model answers given at the end of this unit.

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17.6. SUMMARY

The remote sensing in one of the recent technology of the space research of 21st century. It is a time and cost effective technology. There are many satellites have been launched by many countries and the existing satellites in the space are IRS, SPOT, LANDSAT, ERS, NOAA, etc. These satellites have different sensors namely LISS-I, LISS-III, LISS-III in IRS, RBV and MSS in LANDSAT. Based on the sensor, the resolution of the ground objects varies differently. The basic theory behind sensors is principles of physics interms of generation, propagation of electro magnetic spectrum (EMR). The EMR is generated whenever the size or direction of electric or magnetic field fluctuates with time. The energy detected by remote sensing over a spectrum of EMR is partitioned between its source and the materials with which it interacts on its way to the detector. There are three kinds of spectra can be measured for any material namely absorption reflection and emissions.

The applications of remote sensing data is increased in recent years. These applications are in geology, petroleum exploration, engineering, town planning, groundwater, agriculture, forestry, wildlife ecology, geobotany, archeology and in environmental studies. The environmental studies include water pollution detection, flood damage estimation, landslides and in natural calamites estimation. The satellite data also widely used in EIA. The increased human activity on the land resulting in adverse environmental effects, these includes the construction and operation of highways, rail roads, pipe lines, air ports, industrial sites, power plants and transmission lines, sanitary landfill, radio active waste disposal, timber harvesting and strip mining. Thus the input of remote sensing is essential in the environmental studies which is a time and cost effective technology of 21st century in the world.

17.7. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Remote sensing is defined as the art of deriving information about an object or an area without in touch with it.
2. The absorbance of electromagnetic energy in the atmosphere is restricted to specific wave bands.The wave bands that pass relatively undiminished through the atmosphere is referred to as atmospheric windows.
3. The sensor means that it is a device that receives EMR and converts into a signal that can be recorded and displayed as either in numerical data or an image.
4. There are two types of sensors present in the IRS satellite, .These are linear imaging and self scanning (LISS-I) and LISS-II. The resolution of these are 72.5 metres and 36.25 metres respectively.
5. The geological remote sensing comprises manual and digital analysis of images from remote sensing of passive and active systems.It covers a wide range of EM from the ultra-violet through visible, near-infrared, thermal infrared and to microwave region.
6. The remote sensing applications are in geology and its sub-discipline:land use and land cover,wet land studies, urban and regional planning, agricultural science, foresry, wildlife ecology,water resources, archeology and EIA.

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17.8. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 10 lines.

1. Define the Stefan Boltsman law.
2. What is Wein's displacement law.
3. What is Mie-scattering.
4. Mention the resolution of LISS-III sensor in IRS satellite.
5. What is environmental satellite.

II. Answer the following questions in about 30 lines .

1. Describe the geological remote sensing.
2. Describe the remote sensing applications.
3. Describe the remote sensing applications in Environment impact Assessment studies.

Dr. M. Jafaruddin

BLOCK - 5
POLLUTION & MANAGEMENT

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UNIT-18: SURFACE WATER POLLUTION

Contents

18.1. Objectives
18.2. Introduction
18.3. Types and Sources of Surface Water Pollution
  18.3.1. River Water Pollution
  18.3.2. Lake Water Pollution
  18.3.4. Marine Water Pollution
18.4. Treatment of Polluted Waters
18.5. Summary
18.6. Check Your Progress : Model Answers
18.7. Model Examination Questions

18.1. OBJECTIVES

After completion of this unit, you will be able to :

* describe the types of surface water pollution,
* identify the sources of pollution,
* explain the nature of treatment of polluted water,
* define the toxic wastes.

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18.2. INTRODUCTION

Man is the biggest polluter. His activities have led to the generation of great amounts of pollutants of varied kinds and the introduction of poison in the food chain leading to impairment of health and deterioration in the aesthetic quality of the landscape. Both sewage from domestic and municipalities and effluents from industries are polluting water bodies such as rivers, lakes and the sea. In 1981, it is estimated that the urban and rural communities in India daily generated 74,500 million litres of polluted waste water, which found its way into the other water bodies. By A.D. 2000, this may lead to at the rate of 1,10,000 million litres per day.

18.3. TYPES AND SOURCES OF SURFACE WATER POLLUTION

In general the surface water pollution may be classified into three types : a) River water pollution, b) Lake water pollution and c) Marine water pollution. Sources and nature of river, lake and sea pollutants are described in detail.

18.3.1. River water pollution

In India, all the major rivers, which meet 85% of the drinking water needs of the country, are polluted (Table 18.1). They are heavily loaded with organic waters, especially animal manure, human excreta, decaying vegetable matter and micro-organisms including pathogens. The waste water produced by industries are characterised by organic and inorganic toxic matter (Pb, Zn, Cr, Cu, Cd, Hg etc) at the rate of 55,000

million m^3 every day - 68.5 million of this being discharged into the rivers. For example, a) the Ganga is no more the life - giving river that it was. It has degenerated into the northern India's gutter, carrying all kinds of filth, garbage, sludge and effluents from cities/towns with their industries and populations, b) the holy city of Varanasi adds every year as many as 300 half-burnt human bodies, 200-300 tonnes of ash, 140-200 tonnes of flesh, 6000 carceasses besides more then 340,000 million litres of municipal sewage, c) the capital of India New Delhi contributes 109,500 million litres of waste waters annually, d) the bacterial content of the Ganga water shows a load of 600,000 cells of coliform per litre and 48,000 cells of streptococci per litre (6,48,000 cells/l against the permissible limit of 200,000 cells/l), e) due to dumping of various industrial effluents, most of the rivers in Kerala are heavily polluted, the polluted waters are characterised by high contents of TiO_2, compounds of Zn, Pb, Cr, Cu, Mn and alkalies and f) the Zvary of Goa is polluted both by the agro-chemical industry and by indiscriminate dumping of iron ores on the land and in the river.

Table 18.1 Volume of Waste water discharged into rivers by cities / towns with population > 100,000

Rivers	No. of cities/ towns with population > 100,000	Volume (million litres per day)		
		Generated	Collected	Treated
Brahmani	1	25.1	7.83	Nil
Brahmaputra	1	28.0	Nil	Nil
Ganga	48	2588.19	1696.21	529.28
Godavari	7	213.7	168.04	68.10
Kaveri	10	118.4	34.30	21.20
Krishna	18	711.5	536.51	416.75
Mahanadi	5	138.7	113.98	40.86
Mahi	1	72.64	72.64	83.99
Narmada	1	43.6	Nil	Nil
Pennar	1	13.1	8.17	Nil
Sabarmati	2	103.1	108.96	18.16
Sindhu	8	285.8	175.72	22.7
Subarnarekha	2	103.0	108.96	19.16
Tapi	7	126.7	63.90	42.9

Generally, the dissolved oxygen (DO) in water degrades the wastes and thus, under normal conditions, brings about purification (Fig. 18.1). However, if the quantity of wastes becomes high, the DO is not sufficient and not able to effect biodegradation and purification. The oxygen in water is consumed by the micro-organisms feeding on organic pollutants, that is called "bio-chemical oxygen demand (BOD). The higher the number of micro-organisms, the greater the consumption of DO and the greater the extent of eutrophication. The DO of Gomati river at different places has fallen below 4 mg/l, the Ganga water at Kanpur and Calcutta have DO much below the critical level of 3 to 4 mg/l.

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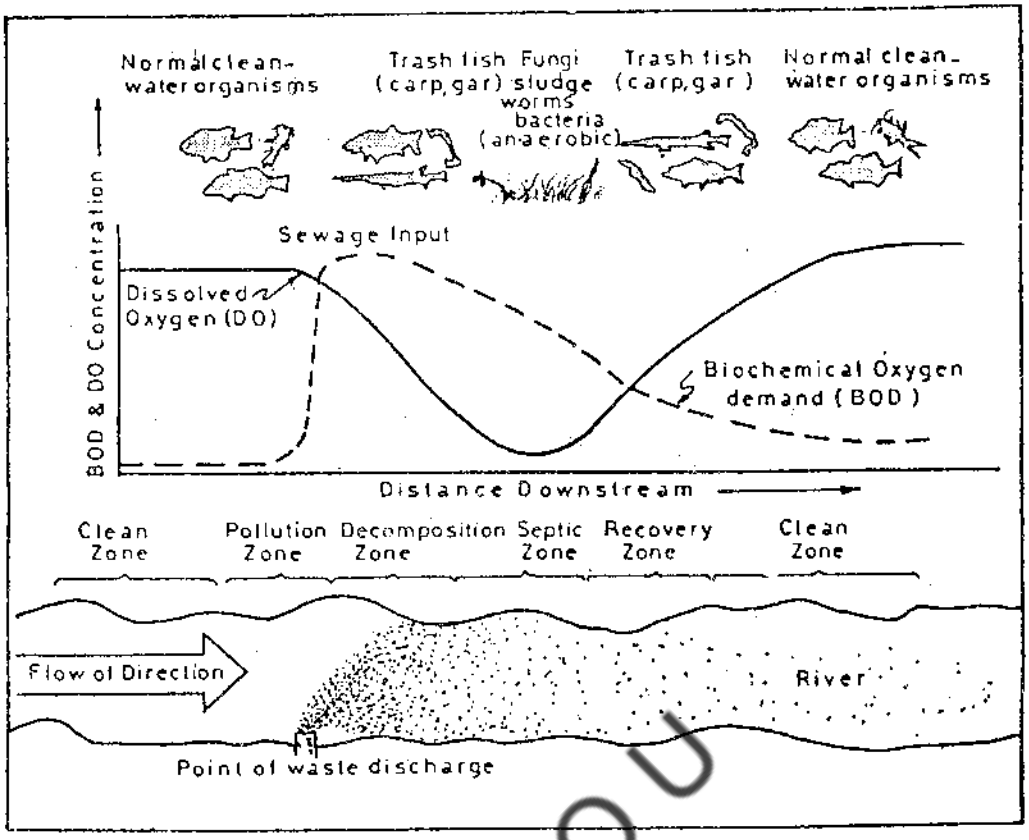

Fig. 18.1. A sewer drain of a city causing pollution of river water. The organic pollutants make a great demand on the dissolved oxygen for their biodegradation. If the oxygen content is high enough, the water is able to recover (self purify) quickly, as the composition of the organisms living in the river indicate.

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As mentioned in Table 18.2, domestic and municipal sewage,contain high quantities of phosphate, nitrogenous compounds, potassium and carbon. They serve as fertilisers and stimulate excessive growth of algae and other aquatic weeds which further overburden the river water with pollutants. The result is a further depletion of oxygen from an already oxygen - deficient ecosystem. The death and decay of these weeds make the waters murky and still more polluted and malodorous.

Table 18.2 Nutrient-contents (mg/1) of domestic waste water

Type	Total Nitrogen (N)	Total Phosphate (P_2O_5)	Total Potash (K_2O)
Raw sewage	60 - 70	20 - 25	40 - 45
Primary treated sewage	60 - 70	20 - 25	40 - 45
Secondary treated sewage	15 - 20	15 - 20	35 - 40

The threshold value of pathogens is 200 cells per millilitre of water. The river contain many times higher amounts of bacteria, viruses and coliforms, particularly where the sewage of the cities/ towns is discharged into the rivers without treatment. 60-80% of

e diseases of Indians are related to infection in the alimentary canal, such as iarrhoea, dysentery, typhoid, jaundice, cholera etc., with polluted waters.

Table 18.3 shows the water pollutants from some major Indian industries. The effluents from industrial units and power plants carry various salts, metal compounds and finely divided metals that increase the acidity or alkalinity and toxicity of water. Many detergents, pesticides and related organic compounds including DDT are not degradable by bacteria, so that the waters, become hazardously toxic in view of the fact that India is annually producing and using 14,000 tonnes of DDT 41,000 tonnes of BHC.

Table 18.3 Water Pollutants form some major Indian Industries

Industry	waste water generated (million m^3/yr)	Pollutants BOD (mg/l)	COD (mg/l)	Suspended solids	Others
Coke oven	9	200-1200	1000-3000	50-500	Phenol, cyanide. tar, Oil, NH3, CN, CNS
Cotton	1530	200-350	400-800	350-550	Chlorides textile
Dairy	-	816	1340	690	Oil, Grease
Distillery	22	15000-40000	3000-8000	4500-12000	Potash, Nitrogen, Cl, SO_4
N-fertilisers 52	-	-	-		Nitrogen, Phosphate. Arsenic, Fluoride
Paper & pulp	450	160-165	610-725	375-410	Chlorides
Pesticides	-	0-700	3000-10000	-	Org., Nit. Sulphates
Refinery	15	100-300	320	200-400	Phenol, Sulphates, Chromium, 1/2 isophote, Oil, H_2S, RSH, NH, Nitrogen, Pho.
Sugar	225	300-2000	600-4000	220-800	Nitrogen
Tannery	-	1700	3500	1099	Cr, Sulphates, Tannin. Oil
Varicose rayon	-	-	210	200	Zinc, Polysulphate

Mining and ancillary activities also contribute significantly to river pollution, mainly due to the rains, which are washing the mine wastes downstream, joining the river bed. The Tiri stream, which drains the Pb-mines at Zawar (Rajashtan), is polluted for 15 km. downstream. The Damodar flowing through the coal-mining belt (Bihar) is one of the very heavily polluted rivers. Not only the industries (fertiliser plants of Sindri and power plants of Bokaro) the coal mines are also contributing pollutants in a big way. Exposure of fresh rocks due to coal-mining initiates weathering, with inevitable oxidation and hydration of such minerals as pyrite, marcasite, siderite, limonite etc., which produce sulfuric acid and soluble sulphates and oxides causing pollution of water. Similarly at Singrauli coalfields, Uttara Pradesh, the water accumulated in depressions caused by opencast mining and the streams draining the area shows higher contents of Ca, Mg, Na, K, Fe and Al, derived from coal seams and associated rocks. In addition to this, flora and aquatic life was affected.

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Check Your Progress 1 & 2

1. Identify the pollutants in river water?
2. What is dissolved oxygen (D.O.)?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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18.3.2. Lake Water Pollution

The waters of ponds, tanks, reservoirs and lakes are not able to revive or purify themselves when their DO is consumed in oxygen-demanding bio-chemical processes which take place due to the influx of organic wastes. The prolific growth due to the presence of phoshpate and nitrate nutrients and overcrowding of algae and weeds and their eventual death and decay creates the same situation. The result is the rapid setting of anaerobic conditions. Lack of oxygen and pungent smell of H_2S, a lake suffers eutrophication, resulting in the destruction of its productivity (Fig. 18.2).

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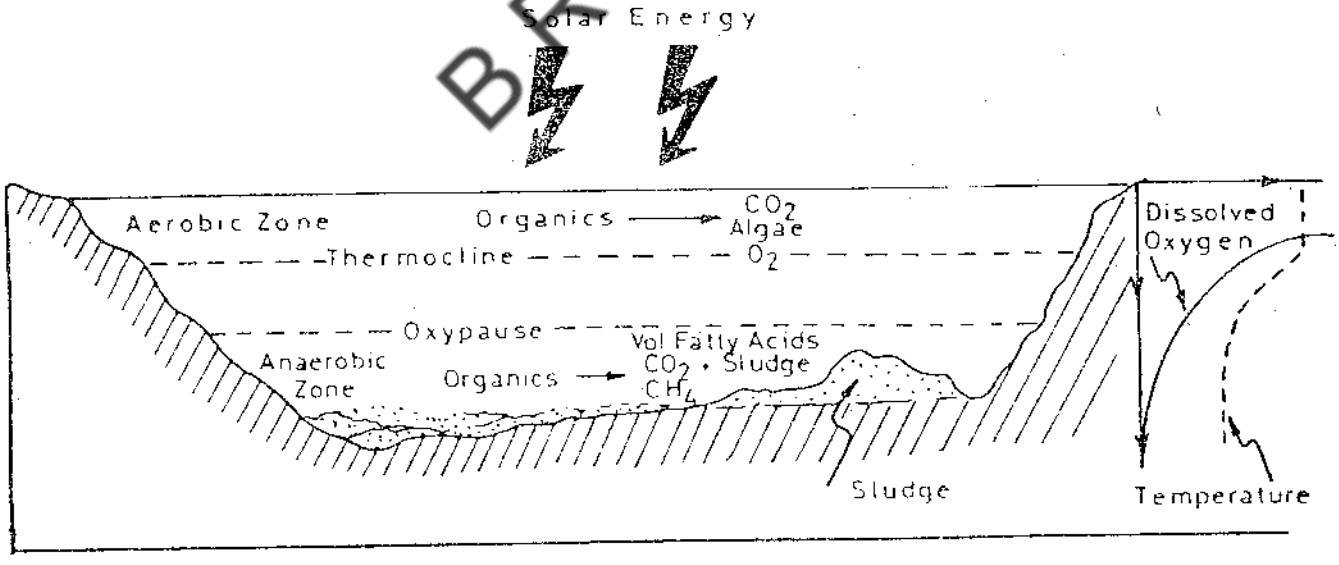

Fig. 18.2. In a standing body of water such as a lake, anaerobic conditions develop at the stagnant lower levels, while the upper part may continue to have dissolved oxygen and solar radiation.

The Naini Tal lake in the Kumaun Himalaya is a well-nourished lake in terms of phosphatic and nitrogenous compounds derived from organic sewage from the many open drains (Fig. 18.3). The contents of these pollutants have been steadily rising

since 1954. About 0.239 million m^3 of sediments was deposited in the lake at the rate of 0.022 million $metre^3$/yr. during the period of 1960-77. If the erosion is not checked, the lake will be completely filled within the near future.

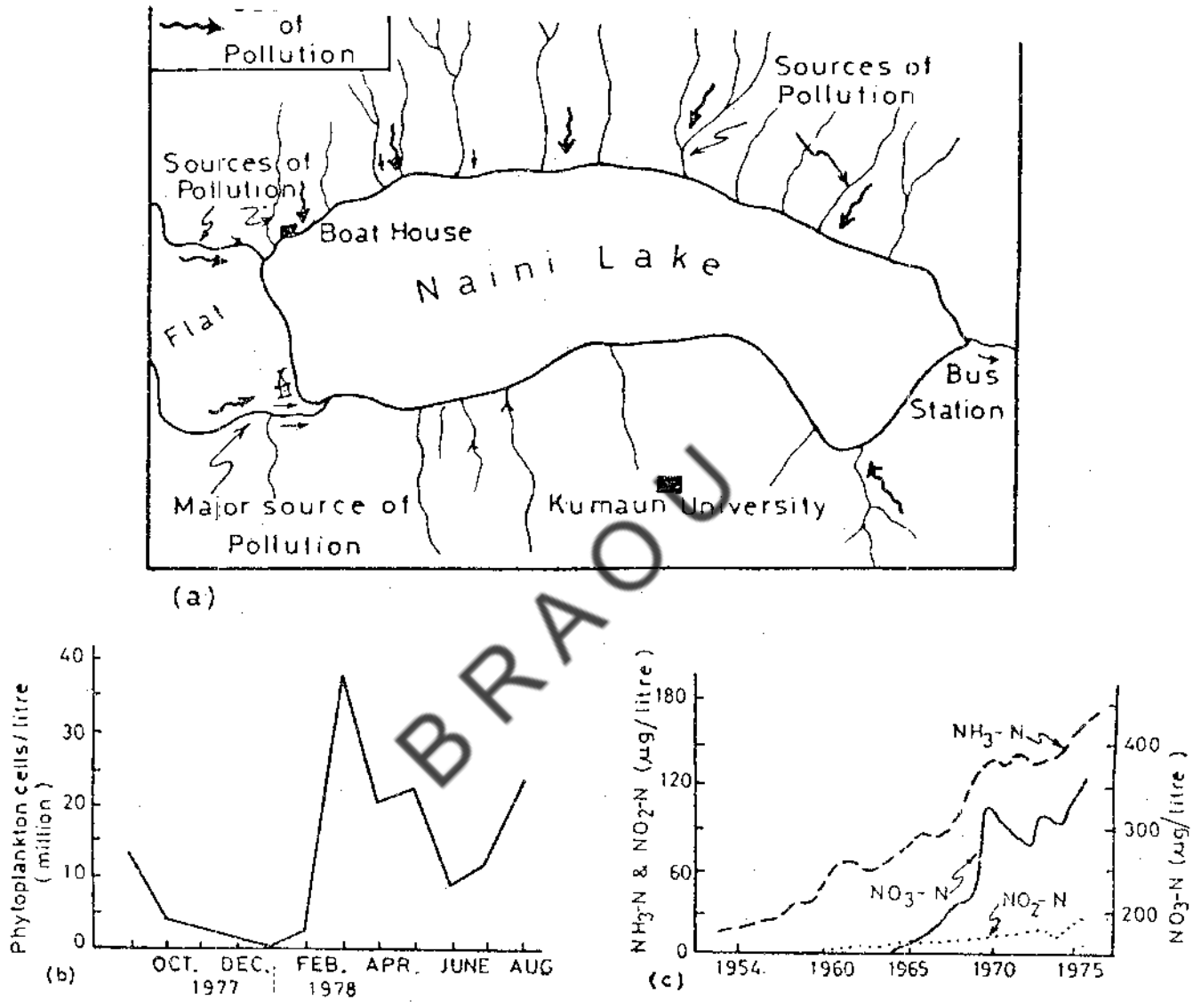

Fig. 18.3. The Naini Lake in the Kumaun Himalaya is a well-nourished lake in terms of phosphatic and nitrogenous compounds derived from organic sewage from the many open drains, lakeside establishments and unchecked open defaecation around the lake. The contents fo these pollutants have been steadily rising since 1954, as is evident from the prolific growth of phytoplanktonic weeds.

The dying Dal lake of Kashmir valley contains more contents of NH_3-N, NO_2-N and phosphate due to inputs of domestic garbage and sewage carrying 16 tonnes of phosphorous and 365 tonnes of nitrogen per year. Thus, the fish population has declined following damage and destruction of their spawning and breeding areas.

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18.3.3. Marine Water Pollution

The coastal belts of ocean, which yield 90% of the world's marine food are being increasingly threatened by pollution through sewage discharges, spilling of petroleum from offshore oil-wells, tanker wrecks, offshore drilling and various dock operations.

The coastal areas, which supply 80% of the sea food in India are becoming increasingly polluted by sewage discharged by cities/towns and effluents from the coastal industries. For example, Bombay dumps 0.40 Km^3 of sewage and 0.095 Km^3 of industrial effluents every day so that the total pollutant annually added an amount of 50 Km^3. In fact, domestic municipal sewage from the coastal Indian population amounts to 35 Km^3, solid wastes 90 million tonnes, industrial effluents 3.5 Km^3, inland effluents 0.14 Km^3, pesticides 12,500 tonnes and detergents 31,250 tonnes (Table 18.4).

Table 18.4 Sources of pollution of coastal waters in India

Source	Amount added per year
Detergents	31,250 tonnes
Domestic-municipal sewage	35 Km^3
Effluents from inland industries brought by rivers	0.1 Km^3
Industrial effluents by coastal industries	3.5 Km^3
Pesticides	12,500 tonnes
Solid waste	96 million tonnes
Tar deposited as a result of oil spills	750-1000 tonnes

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Another major cause of sea water pollution is petroleum oil added 2 to 5 million tonnes annually. About 0.9 million tonnes of this quantity is derived from offshore exploration and development of seabed mineral resources. Pipeline breaches, tanker accidents and offshore blowouts contribute more than 1.5 million tonnes. Disposal from engines and machines account for more than 1.5 million tonnes. The recent giant oil slick formed as a result of release of 30,000 - 50,000 barrels of crude oil from the Nowroz oil-field in Iran covered two-thirds of the Gulf of Iran, encompassing the coasts of Qatar, Bahrein, Kuwait and Saudi Arabia and threatening water-desalinisation plants and spawning-breeding grounds of fishes.

The dock basin of Bombay is yielded 90,000 litres of recoverable waste oil in a year. Similar situation is prevalent in the docks of Madras and Visakhapatnam. In the Indian coasts upto the depth of 20 m, the petroleum hydrocarbon content is 0.2 to 0.05 ppm in the southern sector and 0.005 to 0.001 ppm in the eastern coast. Thus, the western coast is comparatively more polluted than the eastern coast.

The effects of oil pollution on the ecosystem are profound. The concentration of lead (Pb) in the marine waters has increased by a factor of 3 to 5 due to the introduction of lead-based petroleum additive. The primary productivity of diatomaceous communities has declined, while the growth of blue-green algae and flagellate has increased. Highly toxic aromatic hydro carbones are instrumental in causing the death of a number of aquatic organisms, especially the bottom-dwelling shellfishes. Some of the

hydrocarbons like the cancer-causing benzopyrene have got into the food-chain through the fatty tissue of marine organisms. Oil-slicks commonly attract sea-birds and cause mass mortality by poisoning.

Check Your Progress 3 & 4

3. How oil spills are developed along sea-shore?

4. What are the important sources of coastal waters pollution?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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18.4. TREATMENT OF POLLUTED WATERS

This section includes treatment of domestic and industrial organic waste water and toxic wastes.

18.4.1. Domestic and Industrial Organic Waste Waters

If there are no disease carrying pathogens and toxic elements, the nutrient-rich sewage can be utilised straight away for irrigation. Removal of pathogens and toxic elements would make the waste water more useful. The biological methods of treatment involves holding the sewage in a tank, pond or ditch for several days so that coarse particulate matters settle down and finer particles coagulate through use of Fe and Al salts or lime and caustic soda. The liquid is then filtered through a mesh screen and allowed to tricks down through filters of sand or diatomaceous earth. The filtered liquid fraction is then aerated by passing oxygen, which also removes H_2O and CO_2. This process stimulates bacterial activity leading to biodegradation of fine or colloidal organic matter left in the liquid. This type of treated liquid can be utilised for all purposes, except drinking purpose. Resort to chlorination inappropriate dosage kills pathogen bacteria. The muck collected from the settling tanks can be used as manure.

A complementary process involves symbiotic activity of algae and bacteria in the presence of sunlight, free oxygen and nutrients present in the waste water. The prolific algal growth consumes CO_2 and excess pollutants (nutrients - phosphates and nitrates) and release abundant oxygen. The result is the cleaning of the waste water.

18.4.2. Toxic Wastes

Industrial effluents rich in the toxic elements including pesticides and detergents, are subjected to physico-chemical treatment-adsorption on activated carbon, neutralization, thermal reduction and ion-exchange. Intense nuclear radicals in water estimates trace organic and inorganic pollutants including pesticides and pathogens.

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Water hyacinth, which doubles its biomass every eight days and today covers 25-40% of the water courses in India, is capable of clearing up metals by absorbing Cd, Ni, Cr, Zn, Cu, Fe present within the waste water. The weed can be used for generating biogas and for making cement boards and paper.

Check Your Progress 5 & 6

5. What is the use of chlorination ?

6. Describe the water hyacinth ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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18.5. SUMMARY

Environment gets pollution mainly with the activities of man. Both domestic and industrial wastes are polluting water. The urban and rural communities are generating large quantities of polluted water everyday. Water pollution is classified as river water pollution, lake water pollution and marine water pollution.

85% of the drinking water needs of our country depends on river water, which are polluted. The river waters are mainly loaded with animal manure, human excreta, decaying vegetable matter, pathogens etc. The waste water released by industries are also polluting the river waters. Municipal and domestic waste also cause pollution to river waters. Mining and ancillary activities also contributes, significant pollution to river waters. The pollutants may effect flora and aquatic life.

The waters of lakes, ponds, tanks, reservoirs are also polluting by the municipal, domestic, industrial waste. In this lake water pollution it is not possible to purify the waters naturally. Whereas, in river water pollution the waters can be purified to certain extent naturally. The Naine Tal lake in Himalayas and Dal lake of Kashmir are the best examples of lake water pollution.

The coastal waters are being increasingly threatened by pollution with sewage discharges, oil spills, blowouts, off shore drilling and dock operations. 80% of the sea food is generating from the coastal areas. The pollution of coastal waters effects the marine organisms. The persons who consume such food may be effected.

Domestic and industrial organic waste waters can be treated with biological method and symbiatic activities. If there are no desease carrying pathogens, these waste are useful for irrigation without treatment. Toxic wastes can be treated with physico - chemical treatment adsorption on activated carbon, neutralization, thermal reduction and ion-exchange.

Certain types of weeds for example water hyacinth are capable of cleaning up of metals by absorbing from the waste waters.

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18.6. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The pollutants in river water are the animal manure, human exerts, decaying vegetable matter, micro organisms, Pb, Zn, Cr, Cu, Cd, Hg, etc.
2. Dissolved oxygen is the amount of oxygen in waters in dissolved condition. This is useful for the purification of water naturally.
3. The accidental or deliberate dumping of oil into the coastal waters results the formation of oil spills.
4. The important sources of coastal water pollution are the sewage discharge, oil spills, flow-outs, off shore drilling, dock operation etc.
5. The process of chlorination kills pathogenic bacteria.
6. Water hyacinth is a weed which absorbs toxic metals from waste waters.

18.7. MODEL EXAMINATION QUESTIONS

I. Answer the following in 30 lines.

1. Describe the causes of river water pollution.
2. Explain the sources of marine water pollution.
3. Write note on "Treatment of domestic and industrial organic waste water".

II. Answer the following questions in 10 lines.

1. Describe the reasons of lake water pollution.
2. Explain the treatment of toxic wastes.

BRAOU

Dr. N. Subba Rao

UNIT-19: SOLID WASTE DISPOSAL - ENVIRONMENTAL IMPACT

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19.1. OBJECTIVES

After completion of this unit, you should be able to :

* describe environmental hazards with solid waste disposal,
* explain how to control surface and subsurface pollution with solid waste,
* describe the measures to make beneficial products from solid waste.

19.2. INTRODUCTION

Rapid urbanisation, industrialisation, green revolution with fertilisers and pesticides in agriculture brought many problems to environment. Gas and liquid effluents and solid waste are the refuse of industries and domestic waste. Industrialised societies consume enormous amounts of materials. The manufacturing, mining and ultimate disposal of the by-products of civilization impose a tremendous alteration of natural systems. Such refuse is not only harmful to the normal living process of plants and animals, but disruptive to human society.

19.3. MUNCIPAL WASTE

Garbage generated in the domestic routine is mostly of organic substances. It is a common observation that this solid waste is heaped up in the backyards of every home in the villages. Sometimes it is dumped in shallow pits. Cattle is another important factor in the villages. Cattle feed rejects and dung are usually dumped in separate pits. In the towns and cities, the garbage is collected systematically from different centres and carried to a far-off place in the outskirts. In the urban areas, the solid waste

includes not only the garbage from the domestic and market places but also all kinds of refuse from shops and minor industries which may include some inorganic materials and also demolished construction materials. Usually, the solid waste is thrown on the open ground as a dump.

19.3.1. Air Pollution

Disposal of solid waste on the open ground presents unaesthetic sight. Garbage and certain chemical dumps spread bad smell. Wind carrys particulate matter from the dumps which is suspended in the air. Its concentration at more than 150 $\mu g/m^3$ for 24 hours is hazardous. Decay of organic substances generate gases as nitrogen oxides, hydrogen sulphide, and volatile hydrocarbons like methane, which are harmful.

19.3.2. Groundwater Pollution

Groundwater is said to be pure as it is filtered when percolating through soils and Geological formations. But the rainwater when infiltrating through the same formations from the surface dissolves certain chemical compounds including gases, modifies its composition from place to place depending on the nature of formation it is traversing. Water is a powerful solvent. It dissolves certain organic and inorganic substances as it comes in contact with them.

Garbage and other solid wastes mentioned above become sources of groundwater contamination. When, the rain water falls on these dumps or surface water passes through it, dissolves certain organic and inorganic compounds and become a leachate. The leachate infiltrates through the soil zone and the geological formation below and reach the groundwater body. The leachate contains high range of total dissolved solids (TDS), alkalinity, hardness and nitrates. Iron, manganese and trace elements are also added. B.O.D. (Biological Oxygen Demand) is also high. Gases such as methane, carbon dioxide, ammonia and hydrogen sulphide generated in the landfills are dissolved in the leachates. The composition of leachate, however, depends on the nature of the materials dumped.

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The leachate with high concentration of chemical constituents forms a plume in the groundwater body. It spreads in the direction of flow. It is diluted as it moves away from the source point. This is due to dispersion and absorption of certain chemical constituents in the aquifer materials (Fig. 19.1). The size of the plume depends on the leachate produced from a solid waste. This in turn depends on the area of spread of the dumps, nature of the soils and more important the amount of water passing through it. If the surface soils or the geological formation are porous and permeable, the leachate infiltrates with less resistance. If they are impermeable, the leachate would go only as a surface flow and it may join the nearby surface water bodies or infiltrate from an other area where the permeability is favourable. The problem is severe in humid areas of high rainfall. In arid zones with scanty rainfall, with little or no groundwater recharge and very deep water table, there may not be groundwater contamination from the solid waste dumps.

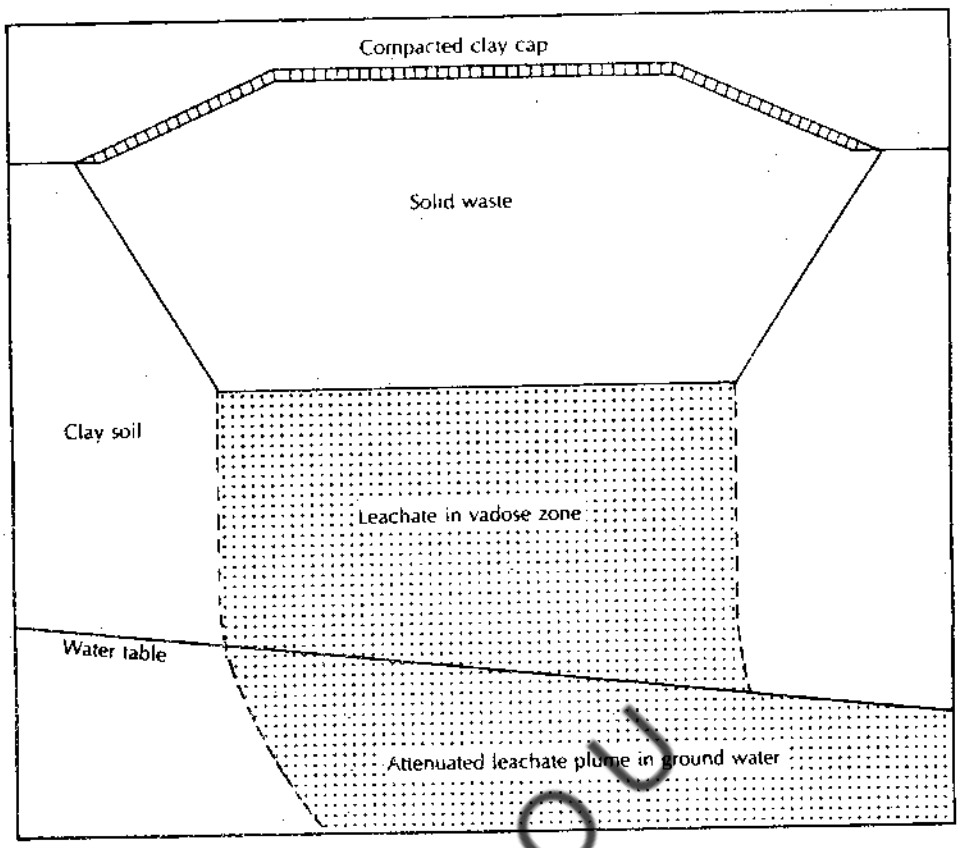

Fig. 19.1. Natural-attenuation landfill. Clay soils attenuate to varying degrees depending upon soil type and leachate. Attenuated leachate passes through the unsaturated zone to the water table, where a plume is formed. (Valdiya 1987)

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Check Your Progress 1 & 2

1. What are the gases generated from garbage ?
2. What is a leachate ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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19.3.3. Sanitary Landfills

The solid waste should be subjected to land burrial in shallow excavations either above water table (upper surface of zone of saturation) or extending below, which is called LANDFILL. It is covered on the surface with compacted clay cap, so that it is not exposed to atmosphere.

Sanitary Landfill is constructed according to engineering specifications to minimise damage to the environment. (Fig. 19.2). Ideal location for landfill is the area with deep water table condition so that the trench or pit can be made in the vadose zone. The leachate when passes through this zone undergoes natural attenuation due to ion exchange and adsorption in the soil. Clayey formation is more suitable as it has the maximum attenuation capacity. Formation of leachate can be avoided or minimised if the land fill is covered on the surface with a layer of about one metre thick compact clay cap or a polythelene sheet. This avoids entry of rain water. Secondly, it protects from air pollution. It also gives an aesthetic look.

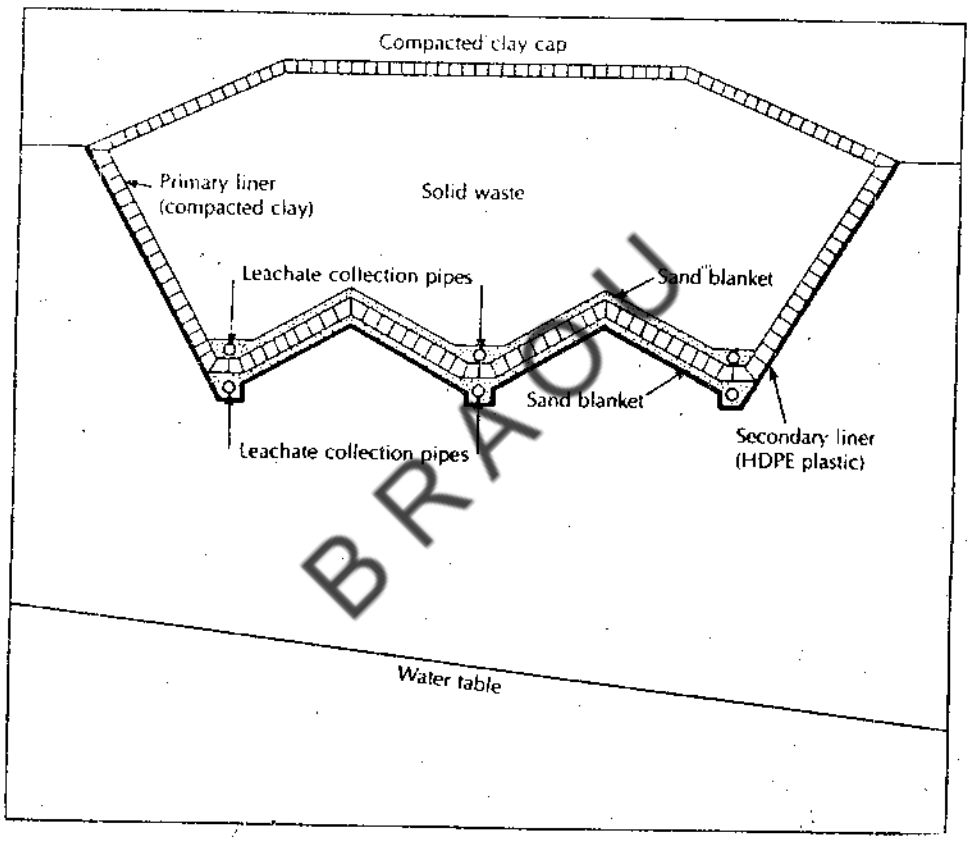

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Fig. 19.2. Double-lined landfill with leachate collection system. Primary liner consists of five feet of compacted clay soil with hydraulic conductivity of nomore than 1 x 10^{-7} cm/sec. Secondary liner is flexible membrance such as 40 mil HDPE plastic. Leachate collection system consists of one-foo-thick sand layers with perforated pipes, which drain to a leachate collection tank. (Valdiya 1987)

Such landfills, however, cannot control leachate and the groundwater contamination below effectively. Therefore, groundwater pollution can be minimised by providing lining also on the sides and bottom of the trench. The liner is compacted clay soil of 1 to 3 m thick. At the bottom, a layer of sand or gravel is provided studded with perforated pipes. The leachate which accumulates at the bottom is drained out through these pipes and treated. Still it is possible that 10 to 30 percent of the leachate may seep through the clay layer. A secondary liner is also provided with polythelene sheet

below the clay layer. At the bottom again another sand layer with drain pipes is arranged to remove such leakage of leachate.

In some areas where the water table is high i.e. close to the ground surface, the landfill has to be constructed excavating part of the saturated zone below water table. In this case, a recompacted clay liner is provided on the sides to reduce the amount of seepage from the groundwater. A leachate collection system is provided as in the above case. In another method the water table is lowered below the landfill through underdrains beneath the liner. Then the landfill is similar to that in unsaturated zone.

19.3.4. Beneficial Uses

The Muncipal waste can be sorted into garbage, scrap metals, glass and paper. Except garbage other substances can be subjected to recycling to produce the same materials newly. Estimates show that about one-third of the garbage can be converted into compost which is a natural manure to the crops. The dried up organic substances can be burnt to generate bio-gas. Pyrolysis is another process which involves thermal decomposition of the waste in an oxygen deficiency condition which produces oil, organic solids and inorganic materials. Other processes include vermiculture in which earthworms are grown to use them as manure to the plants. Mini thermal plants can be established by using garbage as fuel for heating. Toilet paper is produced out of garbage in Japan. Another kind of paper is also produced which is used to spread in the fields and to transplant paddy in ferforated holes. This avoids growth of unwanted weeds in the field. Thus the solid waste can be converted into many beneficial products. Such processes may help to protect the environment from many hazards arising from the solid wastes.

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19.3.5. Site Selection for Landfill

Muncipal solid waste disposal has become a problem in many cities due to rapid expansion of the towns. Sites of the yester years became central points in the new extensions. Muncipal water supply in many towns is not meeting the demands of the people. As a consequence, people depend on groundwater for more than 50% of their requirement. Therefore, it is obligatory on the part of administration and public themselves to protect groundwater from pollution. Groundwater pollution is generally irreversible. Prevention is the only way to protect groundwater. Recent experience in Surat of Gujarat State with the outburst of plague exposed the dangers of indiscriminate throwing of garbage.

Muncipal wastes should be disposed as far as possible in sanitary land fills. The land fills should be located far away from the towns where there is no scope for the expansion of the town. If available, it may be located in and around a place which has already undergone environmental degradation. Other wise, the site should have ideal hydrogeological situation. An elevated place is preferable so that rainfall or running water will have limited contact with the landfill. Water table should be deep. Clays or clayey soils and hard rock terrains, are ideal. Basically, the area should provide little scope to form a leachate from the landfill and secondly there should be restricted infiltration to the deeper layers. A good site is one which satisfies maximum of these conditions.

19.3.6. Case Study

Visakhapatnam is a fast growing city. In seventies, the eastern part of the city is occupied by few villages with more open space in between. As it was outskirts of the main city, the open space was used for dumping garbage. In eighties, the entire area developed into colonies with well planned layouts by the Urban Development Authority. As a result, the garbage yard has now become a central point for the newly developed area (Fig. 19.3).

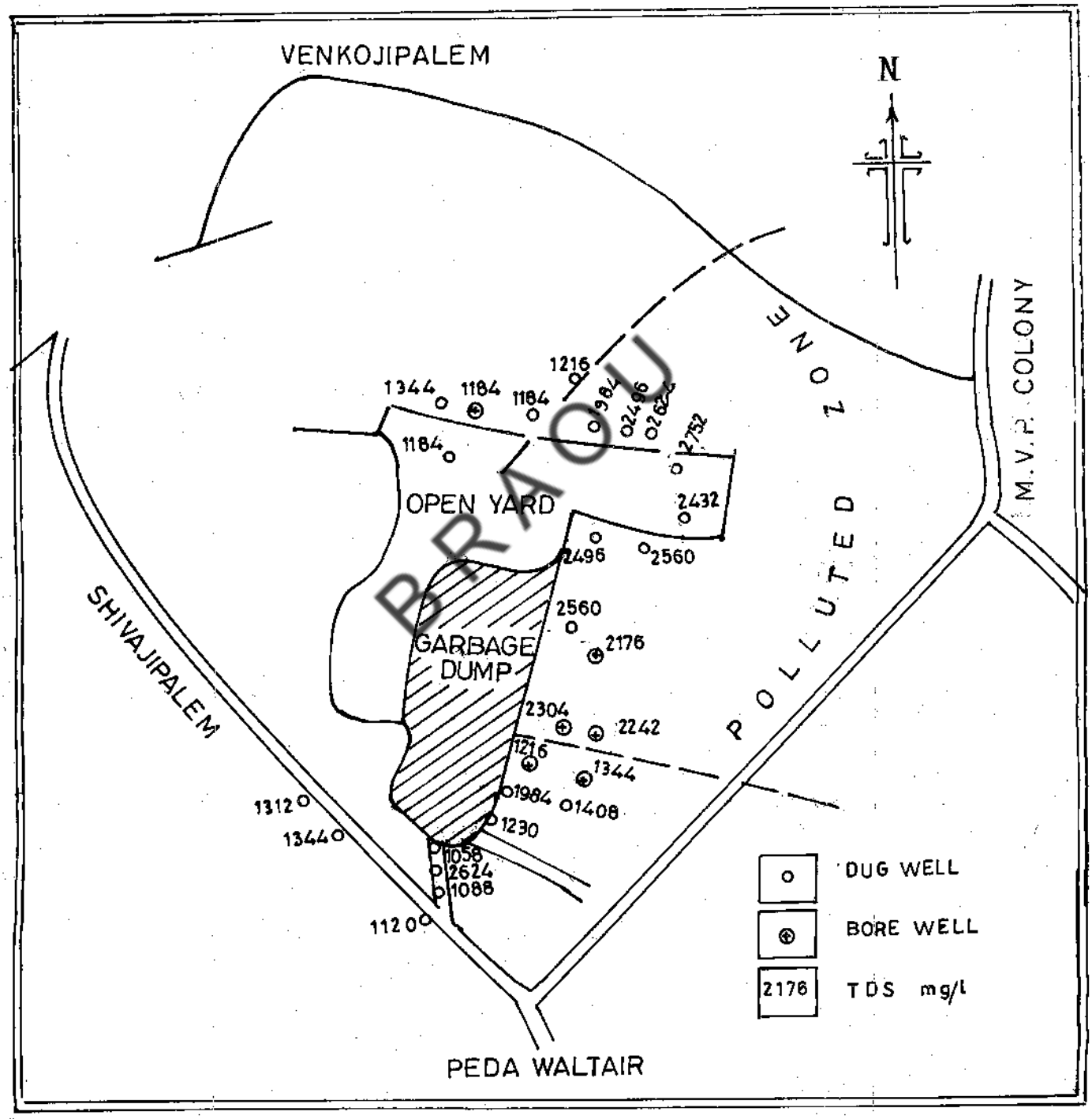

Fig. 19.3. Concetration of total dissolved solids around a garbagedump, eastern part of Visakhapatnam.

The disposal area is a sloping ground with gradient towards east. The area is underlain by red sandy silt soils followed by fluvial sediments and dune sands in different parts. Groundwater is the main source for individual domestic water supply in these colonies. A study on the quality of groundwaters in the area surrounding the garbage yard was taken up in 1994. It revealed that the groundwater in the west, north and south is potable while the eastern part is contaminated with the leachates from the solid waste as manifested by an increase in total dissolved solids chlorides, and nitrates. The extent and direction of the plume could be identified.

Check Your Progress 3 & 4

3. What is sanitary landfill.
4. What are the uses with muncipal waste.

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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19.4. INDUSTRIAL WASTES

Solid materials piled up in the industrial areas include raw materials like ores and chemicals used in the processing and sludge which comes out as effluent after the end product. The nature of these solid materials depend on the industry. For instance, fly ash and slag produced in steel making, ash out of coal burning in thermal plants and red mud in alumina plants constitute 35 to 60% of the raw materials used and become environmental hazard in the vicinity of the industries. Some solid wastes are sludges of chemical substances which are toxic.

Air pollution from the raw materials can be controlled by properly covering them with polythelene sheets, spraying water where applicable so that dust is not raised. Similarly, proper precaution may be taken to avoid forming any leachate underneath. Solid wastes like slag can be used in making cement. Red mud and fly ash are used for making bricks. Chemical wastes can be treated or recycled for extraction of certain chemical substances. Other wasteful and toxic substances should be burried similar to landfills.

19.5. RADIOACTIVE WASTE

Radioactive waste disposal is very problematic since it is a refuse of highest health hazard not by simple contact with air or ground but by mere presence in an area even covered. The hazard is by radiation which can penetrate any solid substance except certain materials like lead. Therefore it requires special chambers or cells constructed with highest scientific technology which can store the refuse for hundreds of years.

Radioactive waste is generated by fission, a process adopted in Nuclear Power Plants. About 99% of the uranium used in the fission comes out as radioactive waste which is a slurry consisting of solid, liquid and gas. It contains dangerous radioactive substances with half life of a few hundred years or even thousands of years. The refuse therefore should be sealed without having any contact with the environment i.e. air, water and earth for such a long time when the radioactivity completely decays and becomes non-hazardous.

In India, low and intermediate level radioactive wastes are stored in concrete lined containers and kept in shallow land depositories with concrete walls. The high level wastes are vitrified in borosilicate glass or synthetic rock and then stored in concrete encased steel tanks. These containers are stored for 20 years or more in deep underground and finally disposed in salt beds or underground salt mines. Generally, the surroundings of such storage places are monitored continuously in air and groundwater for any leakage either in the form of gases or leachate. All these methods do not provide fool proof protection to the environment and it is a potential threat to life. Therefore some countries prefer to throw the radioactive waste in deep seas. In the west some states in U.S.A. and Sweden decided to ban nuclear power plants.

19.6. MISCELLANEOUS

Apart from solid wastes, stacks and piles of mined ores, coal, sulphur etc. are some of the solid materials which are dumped on the open ground in port areas, industrial yards or mine areas. They also have their influence on the environment.

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19.7. SUMMARY

Disposal of urban waste, industrial waste, agricultural waste comes under solid waste disposal. This disposal without proper care will leads to several environmental problems to human societies.

Muncipal waste or urban waste is the garbage collected from residential and market areas. Cattle feed rejects and dung also comes under this category. It also includes all kind of refuse from shops and small industries which consists of organic and inorganic materials. Construction waste is also a solid waste.

Wind carries particulate matter from this solid waste and cause air pollution. Decay of organic matter generates toxic gases which are harmful. Rain water during the process of infiltration passes through this solid waste and dissolves certain inorganic and organic elements and reach ground water body thus causing contaimination of groundwater. If the surface rocks are not porous the dissolved matter flows with surface water and joins nearby lakes or rivers and cause contamination.

Proper design and construction of sanitary land fills may control some extent the environmental pollution of solid waste. There are some benefits from certain kinds of solid wastes.

The muncipal waste can be sorted into garbage, scrap, glass and paper. The garbage is useful to produce compost. The scrap glass and paper can be re-used after the process of recycling. With thermal decomposition it is possible to produce oil, organic solids and inorganic materials from solid waste. Mini thermal plants can be estab-

lished with suing of garbage. Toilet paper is produced out of this garbage in Japan. Such process may help to protect the environment from solid waste.

Muncipal waste should be disposed as far as possible in sanitary land fills. This land fills can be located far away from the cities and towns. Areas underlain by massive hard rocks are suitable for waste disposal.

The industrial wastes are the slag coming out of the industries. Different kinds of industries may release different varieties of effluents. This effluents may contain different toxic elements. Fly ash from steel plants, ash from thermal plants and red mud from Alumina factories may be useful for making bricks. Chemical waste can be recycled for getting some chemical elements.

Radioactive waste are most dangerous to human life. In general the fission process releases 99% uranium as radioactive waste. This should be stored in concrete lined containers, otherwise slow emission of radioactive rays cause health disorders.

19.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The gases generated from the garbage are the nitrogen oxides H_2S, and volalite hydrocarbons like methane.
2. When water falls on waste dumps and passes through it, it dissolves certain organic and inorganic compounds and become leachate.
3. The solid waste should be subjected to land burrial in shallow excavations either above water table or extending below are called sanitary landfills.
4. Mincipal waste can be first sorted out as garbage, scrapmetals, glass and paper. Except garbage others are useful for recycling processes. Garbage is useful for the production of menure and thermal energy.

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19.9. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in 30 lines.

1. Give a detailed account of Muncipal solid waste, its impact on environment and suggest remedial measures.
2. Describe in detail the environmental hazards of garbages dumps.

II. Answer the following questions in 10 lines.

1. Define sanitary landfill and describe its construction.
2. Write in detail about industrial solid waste and their impact on environment.
3. What is a Radioactive waste. How it is disposed.
4. Write in detail how solid waste can be converted to beneficial use.

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UNIT-20: GROUNDWATER POLLUTION

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  20.3.4. Miscellaneous Sources
20.4. Distribution of Groundwater Pollution
20.5. Summary
20.6. Check Your Progress : Model Answers
20.7. Model Examination Questions

20.1. OBJECTIVES

After completion of this unit, you should be able to :

* define the term groundwater pollution,
* explain the basis for classification of pollution,
* describe the different sources and causes of pollution,
* identify the distribution pattern of groundwater pollution,
* describe the evaluation of pollution potential.

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20.2. INTRODUCTION

Groundwater pollution may be defined as the artificially induced degradation of natural groundwater quality. The effect of this not only impair the use of water but also create hazards to the public health. Generally, groundwater pollution originates from the disposal of solid waste and liquid wastes followed by the use of water for a wide variety of purposes. In contrast to the surface water pollution, groundwater pollution is difficult to detect and at times this is even more difficult to control and which may exist for decades. With increasing demands of groundwater resources, efforts are being made to prevent, reduce and to eliminate the groundwater pollution.

Groundwater pollution is the degradation of natural quality which is a hazard to human health.

20.3. SOURCES AND CAUSES OF GROUNDWATER POLLUTION

The principal sources and causes of groundwater pollution can be classified into four categories based on the diversity of human activities on the hydrologic cycle. They are i) Urban disposals ii) Industrial iii) Agricultural and iv) Miscellaneous. The details of each one is described with regard to their occurrence and their effects on quality of groundwater.

20.3.1. Urban Disposals

This category is further sub-divided as i) Sewer leakage, ii) Liquid wastes and iii) Solid waste disposals.

i) Sewer Leakage : Leakage of sewage into the ground is a common phenomena resulting from poor workmanship, defective sewer and pipe, breakage due to tree roots, ruptures from heavy loads or soil slippage, fractures from seismic activity, loss of foundation support, shearing due to differential settlement at manholes, and infiltration causing sewage flow into abandoned sewage laterals. This leakage introduce higher amounts of BOD, COD, NO_3, TDS, Na, PO_4, Cl, organic chemicals and possibly bacteria into groundwater.

ii) Liquid Wastes : In an urban area, wastewater may originate from domestic uses, industries or storm run-off. Most of this waters receives some degree of treatment and is then discharged into surface waters. Shallow wells are widely employed to place surface run-off and sometimes treated muncipal wastewater released into underground in freshwater aquifers. Such disposal wells have been highly objectionable from the health point of view because they release large quantities of pollutants directly into the aquifers. The problem is most critical where the disposal wells are very close to pumping wells. Liquid wastes can introduce bacteria, virus and inorganic and organic chemicals into groundwater.

iii) Solid Wastes : The land disposal of solid wastes is an important source of groundwater pollution. If any land area is filled by these wastes, it will be called "Landfill". Thus, it serves as a depository of urban or muncipal solid waste. Leachate from these landfill can pollute groundwater. Possible sources of water include precipitation and surface water infiltration, percolating water from the adjacent land. The problem of pollution from landfills is greatest where high rainfall and shallow water table occurs and also the existence of landfills in the upstream side of the groundwater flow.

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Important pollutants frequently found in leachate include BOD, COD, Fe, Mn, Cl, NO_3, Total hardness, and trace elements. Total hardness, total alkalinity and total dissolved solids are often increased, while generation of gases. Methane, CO_2, Ammonia and H_2S are the by products of landfills.

20.3.2. Industrial Discharges

Groundwater pollution can occur where industrial wastewaters are discharged into streams, pits, ponds or lagoons, thereby enabling the wastes to migrate down to the water table. As mentioned in the earlier section, the industrial type may also be sub-divided into i) Liquid wastes, ii) Tank and pipeline leakage iii) Mining activities and iv) Oil-field brines.

i) Liquid Wastes : The quality of the wastewater varies with type of industry and type of use. In industrial plants, the major uses of water are for cooling, sanitation, and manufacturing and processing. Cooling water that is softened before use to inhibit scale formation produces wastewaters with salts and heat (thermal) as important pollutants. Sanitation water can introduce higher concentrations of TDS, bacteria and viruses, nitrogen and phosphorous compounds, BOD, toxic dis-infectants etc. Manufac-

turing units include mining, metal plating, fertilisers, pesticides and paper and processing units include pickling, food, fruit-packing and washing. The disposal of hazardous material from these industrial units can produce a variety of groundwater pollution problems such as high TDS, acidity or alkalinity, heavy metals (Cr, Cd, As, Hg, Ni, Fe and Mn), pesticides high COD, brines from softening.

ii) Tank and pipeline leakage : For industrial and commercial installations, underground storage and transmission of a wide variety of fuels and chemicals are common practices. Sometimes, these tanks and pipelines are subject to structural failures and hence subsequent leakage becomes a source of groundwater pollution. Petroleum and their products are responsible for much of the pollution. Leakage is oftenly occurred from gasoline station and home fuel oil-tanks. An immiscible liquid, such as oil, leaking underground moves downward through permeable soils until it reaches the water table. Thereafter, it spreads to form a layer on top of the water table and migrates laterally with groundwater flow. Initially, the gasoline can be removed by boiling and by skimmer pumps. Subsequently, pumping wells created drawdown cones to contain the leakage and to remove a mixture of gasoline and water.

iii) Mining activities : Mines include both surface (open) and underground types, will produce a variety of groundwater pollution problems. Pollution depends on the material being extracted and the mining process. Coal, phosphate and uranium mines are major contributors of groundwater pollution. Similarly, metallic ores of production of Fe, Cu, Zn and Pb are also important contributors. Stone, sand and gravel quarries although numerous, but their effect chemically much less important. Mines invariably extend below the water table and the dewatering is inevitable for further development. Water so pumped may be highly mineralised and is generally referred as "acid mine drainage". Groundwater pollution can also result from the leaching of old mine tailings and settling ponds. Therefore, pollution problems can be associated with both active and abandoned mines. Important pollutants, frequently found in the mining activities include low pH, and high Fe, Al and SO_4. For more information in this regard, please refer unit - 10.

iv) Oil-field brines : The production of oil and gas is usually accompanied by substantial discharges of wastewater in the form of brine. In the olden days, oil-field brine disposal was handled by discharge to streams or evaporation ponds. However, brine-polluted aquifers in both cases become common in oil production areas. Now, oil and gas producers inject most brines through wells into deep formations that are geologically isolated from overlying fresh water aquifers by proper designing and also taking precaution measures to prevent ruptures and to facilitate the detection of leaks. Even though, brine disposal can cause pollution as the surrounding abandoned and unplugged oil and gas wells and test holes provide vertical pathways for injected brines to rise into overlying aquifers.

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Check Your Progress 1 & 2

1. What is groundwater pollution ?
2. Identify the sources of pollution ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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20.3.3. Agricultural Sources

This section includes the effects of irrigation return flow, animal wastes, fertilizers and soil amendments and pesticides on the groundwater quality.

Irrigation return flow : Approximately one-half to two-thirds of the water applied for irrigation of crops is consumed by evapotranspiration, the remainder is termed as "Irrigation return flow", drains to surface channels or joins the underlying groundwater. Irrigation, generally, increases the salinity which is from three to ten times that of the applied water. It is resulting from the addition of salts by dissolution during the irrigation process and also from salts added as fertilizers and soil amendments, and from the concentration of salts by evapotranspiration. Normal characteristics include Ca, Mg, Na, HCO_3, SO_4, and NO_3. Irrigation return flow can be the major cause of pollution of groundwater in arid and semi-arid regions, because irrigation is the primary use for water in such regions.

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Animal wastes : Large amounts of animal wastes are deposited on the ground, where animals are confined within a limited area, as for beef or milk production. Thus, for the 3 to 5 months that a beef animal remains in a feedlot, it will produce over a half-ton of manure on a dry-weight basis. With number of animals in a single feedlot, the natural assimilative capacity of the soil can become overtaxed. Storm-runoff in contact with the manure carries highly concentrated pollutants to surface and groundwaters. These wastes may transport salts, organic loads and bacteria into the soil. High TDS, Na, Cl and NO_3 are the important persistent pollutants that may reach the groundwater table.

Fertilizers and soil amendments : Modern agriculture is based on extensive use of fertilisers to obtain higher crop-yields, when fertilizers are applied to agricultural land, a portion usually leaches through the soil and to the water table. The primary fertilizers are compounds of nitrogen, phosphorous and potassium. Phosphate and potassium-fertilizers are readily absorbed on soil particles and seldom constitute a pollution problem. But nitrogen in solution is only partially used by plants or absorbed by the soils, and it is the primary fertilizers pollutant.

Soil amendments are applied to agricultural lands to alter the physical or chemical properties of the soil for support of plant growth. Application of lime, gypsum, sulfer, organic manures and other methods of desalinisation and dealkalinisation is widely used for this purpose. These soil amendments may eventually leach to the groundwater, thereby increasing its salinity.

Pesticides : The impact of pesticides on groundwater quality depends on the properties of the pesticide residue, rainfall or irrigation rates and soil characteristics. The presence of these materials in groundwater, even in minute concentrations, can have serious consequences in relation to the potability of the water, while others are readily absorbed by soil particles or are subject to microbial degradation.

20.3.4. Miscellaneous Sources

Miscellaneous factors include spills and surface discharges, stockpiles, septic tanks and cesspools, roadway deicing, saline water intrusion, interchange through wells and surface water.

Spills and surface discharges : At the industrial sites causal activities may include boiloners, losses during transfers of liquids, leaks from pipes and valves, and inadequate control of wastes and storm-runoff. Further, washing aircraft with solvents and spills of fuel at airports can form a layer of hydrocarbons which float on the water table. Groundwater pollution can also occur from the intermittent dumping of fluids on the ground, near gasoline stations, small commercial establishments and construction sites. These factors can release large quantities of pollutant at a particular site. Hazardous and flammable liquids are often flushed by water from highways, which may actually aid in transporting the pollutant to the water table.

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Stockpiles : Solid materials, which are raw materials awaiting use or solid washes placed for temporary or permanent storage, are frequently stockpiled near industrial plants, construction sites, and large agricultural operations. Rainwater falling on unsheltered stockpiles causes leaching to occur into the soils, which may transport heavy metals, salts and other organic and inorganic constituents as pollutants to the groundwater.

Septic tanks and cesspools : Septic tanks and cesspools are the widely distributed potential sources of groundwater pollution. These sources are caused by poor drainage facilities or associated with aquifers in which large openings afford direct connection between the surface and groundwater body. These waste materials adds minerals to the groundwater. Important pollutants include high TDS, Na, Cl, SO_4 and NO_3 and bacteria and viruses. Bacteria and viruses are generally removed by the soil profile.

Roadway deicing : Application of deicing salts to streets and highways in winter can create pollution of groundwater. The salts are used to maintain the streets and highways in safe driving conditions throughout the winter in snowfall regions. Urban areas with winter temperatures below freezing are affected and these salts reach the groundwater in solution after spreading on roadways and also from stockpiles. NaCl accounts for most of applications, with CaCl the remainder. These salts have not only produced degradation of groundwater quality but also hastened the corrosion of wells.

Saline water intrusion : Saline water is the most common pollutant in fresh groundwater. The mechanisms responsible for saline water intrusion fall into three categories : i) Reduction or removal of groundwater gradients, which permits denser saline water to displace fresh water. This situation occurs in coastal aquifers in hydraulic continuity with the sea when pumping of wells disturbs the natural hydro-dynamic balance due to heavy pumping, ii) destruction on natural barrier, which separate fresh and saline waters. This construction enables tidal water to advance inland and to percolate into a freshwater aquifer, and iii) It occurs where there is sub-surface disposal of waste saline water, such as into disposal wells, landfills or other waste depositories. The occurrence of saline water intrusion causes higher TDS, Na, Cl and Mg content in the groundwater.

Interchange through wells : Because of wells form highly permeable vertical connections between aquifers, they can serve as avenues for groundwater pollution where inadequate attention is given to the proper construction, sealing or abdandment of wells. Pollution occurs where there is incomplete hydraulic separation within a well and have a vertical difference in hydraulic head exists between two aquifers. Besides, if the top of a well is not constructed so as to divert surface water away from a well, it can admit a wide variety of surface pollutants. Although governmental regulations in most locations require plugging of abandoned wells, many such wells remain unplugged and serve as ongoing interchanges between aquifers.

Surface water : Polluted surface water bodies that contribute to groundwater recharge become sources of groundwater pollution. The recharge may occur naturally from a losing stream or it may be induced by a nearby pumping well. Because many muncipal waste supply wells are located adjacent rivers to ensure adequate flows, they can serve as important groundwater pollution mechanisms.

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Check Your Progress 3 & 4

3. What are the sources of groundwater pollution in agriculture ?
4. What is meant by stockpiles ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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20.4. DISTRIBUTION OF GROUNDWATER POLLUTION

In a large region or basin, bodies of polluted groundwater can be visualised as innumerable scattered dots on a map, while in some areas diffuse sources, such as from irrigation return flows, would create areas with appreciable horizontal extent. Entry of pollutants into shallow aquifers occurs by percolation from ground surface, through wells, from surface waters, and by saline water intrusion. The extent of pollution in groundwater from a point source until a harmful or very low concentration level is

reached. Because each constituent of a pollution source may have a diffcrent attenuation rate, the distance to which pollutants travel will vary with each quality component. The area effected with pollution is termed as a plume.

The shape and size of a plume depend on the local geology, the groundwater flow, the type and concentration of pollutant, the continuity of waste disposal, and human modifications of the groundwater system, such as pumping wells. Where groundwater is moving relatively rapidly, a plume from a point source tends to be long and thin. but where the flow rate is low, the pollutant tends to spread more laterally to form a wider plume. Irregularly shaped plumes can be created by local influences such as pumping wells and non-uniformities in permeability.

Plumes tend to become stable areas, where there is a constant input of waste into the ground. This occurs for two reasons : enlargement as pollutants continue to be added at a point source is counterbalanced by attenuation mechanisms, or the pollutant reaches a location of groundwater discharge, such as a stream, and emerges from the underground. When a waste is first released into groundwater, the plume expands until a quasi-equilibrium stage is reached. An approximately stable plume will expand or contract generally in response to changes in the rate of waste discharge.

It is a fact that groundwater pollution may persist underground for years, decades or even centuries. This is in marked contrast to surface water pollution. Underground control is achieved primarily by regulating the pollution source, and secondarily by physically entrapping and when feasible, removing the polluted water from the underground.

BRAOU

Check Your Progress 5

5. What is a plume ?

Note : (a) Write your answers in the space given below.

(b) Compare your answer with the model answer given at the end of this unit.

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20.5. SUMMARY

Groundwater pollution is the degradation of the natural quality of water which is harmful to human health. Groundwater pollution originates from the disposal of solid and liquid waste from the different sources. The four major sources of groundwater pollution are urban disposals, industrial waste, agricultural waste and miscellaneous.

Pollution of groundwater in urban areas are due to sewer leakage, liquid waste and solid waste. Leakage of sewage is a common phenomena in urban areas. This will cause groundwater pollution and introduces high contents of BOD, COD, NO_3, TDS, Na, PO_4, Cl, organic chemicals and bacteria. These are harmful to human health. Waste water from domestic uses, industries is liquid waste. If the liquid waste disposal wells are closer to drinking water wells, pollution will occur to groundwater. Urban solid waste will be collected in a 'land fill'. During the rainy season leachate will form and then enters the groundwater causing groundwater pollution.

Groundwater pollution can occur where industrial waste water are discharged into streams, pits, ponds or lagoons there by the waste water migrates down to the water

table. Industrial causes are mainly due to the industrial liquid wastes. Tank and pipeline leakage, mining activities and oil-field brines. Without proper treatment industrial wastes are releasing on to the soil. These are entering into groundwater with percolation and causing groundwater pollution.

Groundwater pollution is also occurring with agricultural practices. The irrigation return flow after dissolving several salts from fields are entering open channels. From this due to percolation groundwater is getting polluted. The disposal of animal waste contains pollutants. These are entering into groundwater. The application of fertilisers and pesticides leaves some harmful pollutants in soils. During rainy seasons these are entering into surfacewater and groundwater causing pollution.

The miscellaneous sources for ground water pollution are with spills and surface discharge of hazardous liquids, stock piles, septic tanks and cess pools, roadway deicing of salts, saline water intrusion, interchange of waters through wells, surface water etc.

The distribution of groundwater pollution from a point source decreases as pollutants move away from the source until low concentration level is reached. The area effected is termed as a plume. The size and shape of the plume depends on the local geology, groundwater flow, type and concentration of the pollutant etc. groundwater pollution may persist underground for centuries. So groundwater pollution should be avoided.

20.6. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Groundwater pollution is the degradation of natural quality of groundwater with external or man made process, which is harmful to society.
2. The four main sources of groundwater pollution are 1. Urban wastes 2. Industrial wastes 3. Agricultural source and 4. miscellaneous sources.
3. In agricultural process the irrigation return flow, animal wastes, fertilisers, pesticides may cause groundwater pollution.
4. Stock piles is the storing of industrial or other materials on a open land.
5. In an area the area effected with pollution is called a plume.

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20.7. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in 30 lines each.

1. Describe the sources and causes of industrial pollutants.
2. Explain the sources and causes of urban pollution.
3. Explain the following terms.
   i) Animal wastes ii) Spills and surface discharges and iii) Saline water intrusion.
4. Describe the following
   i) Road deicing ii) Pesticides and iii) Irrigation return flows.
5. Explain the distribution of groundwater pollution.

11. Answer the following questions in 10 lines each.

1. Comment about the fertilisers and soil amendments.
2. Write short notes on :
   i) Septic tanks and cesspools. ii) Interchange through wells.
3. Explain the evaluation of pollution potential.

Dr. N. Subba Rao

UNIT-21: QUALITY OF GROUNDWATER

Contents

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21.1. OBJECTIVES

By the end of this unit, you will be able to :

* describe the sources of dissolved constituents,
* explain the environmental problems,
* describe the treatment of groundwater.

21.2. INTRODUCTION

All groundwater contains salts in solution that are derived from the location and past movement of the water. Environmental problems have been generated due to use of bad quality of groundwater. To control such adverse effects on human beings, treatment of groundwater must be essential.

21.3. SOURCES OF DISSOLVED CONSTITUENTS

The type and concentration of salts present in water depends on the environment, movement and sources of the groundwater. Water quality changes as it travel through the hydrologic cycle from precipitation to groundwater. The details have been given below about the sources of dissolved constituents in terms of physical, chemical and biological parameters.

21.3.1. Physical Parameters

Physical parameters of water include colour, odour and taste, turbidity and temperature.

Colour : It occurs due to iron compounds, dye and organic matter in water and is reported in milligrams per litre (mg/l).

Odour and Taste : These properties are derived from bacteria, dissolved gasses (H_2S. Methane etc.), mineral matter (Fe-compounds, dyes etc.) or phenols. The odour is expressed as disagreeable, earthy, fishy, grassy, mouldy, peaty, sweetish etc. The taste is expressed as brackish, saline, salty etc. The odour and taste are reported in threshold number.

Turbidity : It is a measure of suspended and colloidal matter, in water, such as clay, silt, organic matter, organisms, urban and industrial wastes. It is reported in mg/l.

Temperature : Groundwater temperature varies within wide limits, from freezing to above the boiling point at the surface. Extremes of groundwater temperature are found in areas of polar and volcanic and tectonic activity regions. Such temperature of water are not found in the rest of the earth's crust. The changes in temperature of water can be helpful in detecting the unsuspected source of pollution.

Distribution of groundwater temperature depends largely on terrestrial heat, (Deccan trap terrain groundwaters show temperature between 20 and 40°C), exothermic and endothermic reactions in the rocks, (In the upper Luni basin, Ajmer district, Rajashtan, the temperature ranges from about 19 to 28° C), thermal conductivity of rocks (interbeded sand and clay of Cambay artesian basin, Gujarat, show temperature 1°C per 40 m), thermal waters, (46 - 79°C observed at Jammu and Kashmir, Himachala Pradesh, Maharastra, Haryana and Bihar), atmospheric temperature, infiltration from atmospheric precipitation and surface water bodies, movement of groundwater and human activities such as mining and discharge of wastes.

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21.3.2. Chemical Parameters

The chemical parameters of water is mainly expressed in terms of hydrogen-ion concentration (pH), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), carbonate (CO_3), bio-carbonate (HCO_3), chloride (Cl), sulphate (SO_4), nitrate (NO_3) and fluoride (F) for assessing their suitability for dependable uses. These parameters are called "Major chemical constituents". Other involved constituents are dissolved gases and trace elements.

pH : It is a measure of the acidity or alkalinity of water. The natural water (H_2O) consists of H^+ ions combined with OH^- ions. But the process of dissociation, called hydrolysis, takes place in water and hence it contains uncombined H^+ and OH^- ions. The water becomes acidic (pH<7), when H^+ ions are in the excess than OH^- ions and it becomes alkaline (pH>7), when reverse is the case. For neutral water (pH = 7), the concentrations of H^+ and OH^- ions are equal. The pH value is sometimes taken as a measure of the solvent power of water for various rock minerals, especially in limestone areas. In most groundwaters, the pH value is controlled by CO_2-CO_3-HCO_3 equilibrium. Groundwaters generally have a pH range of 6.5 to 8.5. Industrial effluents in Visakhapatnam area, Andhra Pradesh, show pH ranges from 1.9 to 5.7, while the groundwaters in the same area have 6.6 to 9.2 pH.

TDS : It is a measure of amount of dissolved salts in the water. The bulk of the TDS include Ca, Mg, Na, HCO_3, Cl. SO_4, K, F and NO_3 generally form a minor part of the TDS in groundwaters. It is reported in mg/l. TDS in rainwater is less than 10 mg/l. In groundwaters, its concentration range from 20 in areas of high rainfall to over

100,000 mg/l in desert brines. Brine areas contain more than 300,000 mg/l TDS. Several processes, include movement through rocks containing soluble mineral matter, concentration by evaporation and contamination due to influx of sea water, urban, industrial and agricultural waste disposals, may cause the increase in the TDS content of groundwaters.

Groundwater can be classified according to the TDS content as follows

Groundwater Classification

Water Type	TDS, mg/l
Fresh water	< 1000
Brackish water	1000 - 10,000
Salty water	10,000 - 100,000
Brine water	> 100,000

TH : It is a soap-destroying power of a water caused by the presence of Ca and Mg with combination of CO_3, HCO_3, SO_4 and NO_3 constituents. The TH is of two types - temporary hardness (carbonate hardness) and permanent hardness (non-carbonate hardness). The former type is due to the presence of HCO_3 of Ca and Mg, which can be easily removed by boiling the water, while the later one is due to the presence of SO_4, Cl and NO_3 ions of Ca and Mg, which cannot be removed by boiling the water. It is reported in mg/l. The TH in water derived from the solution of CO_2 released by bacterial action in the soil, in percolating rainwater and in limestone areas. Besides, the different sources of pollutants are also increased the concentration of TH in groundwaters.

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The degree of TH in groundwater is based on the classification listed below

TH classification in groundwaters

Type	TH, mg/l
Soft	< 75
Moderately hard	75 - 150
Hard	150 - 300
Very hard	> 300

TA : It is a measure of amount of dissolved CO_3 and HCO_3 ions in a water and is expressed in mg/l. If the pH is more than 8.2, the waters have CO_3 ions. The TA value in water is controlled by CO_2.

Ca : It is a major constituent of most igneous, metamorphic and sedimentary rocks. Principal sources of Ca in groundwater are minerals like plagioclase, pyroxene and amphibole among igneous and metamorphic rocks and limestone, dolomite and gypsum among the sedimentary rocks. It is also present in sandstone and shale as the cementing material and absorbed ion in soils and rocks. In the presence of CO_2, the content of Ca can be dissolved from 20 to 100 mg/l in waters. Ion exchange process, i.e. exchange of Ca for Na, can increase Ca content in waters. Groundwaters are

generally contain Ca in the range of 10 to 100mg/l. Brines may contain as much as 75,000 mg/l.

Mg : Main sources of Mg in groundwaters are dunites and pyroxenites (igneous rocks), basalts (volcanic rocks), talc, tremolite, schists, and amphibolites (metamorphic rocks), dolomite (sedimentary rock), clay minerals and sea water. Similar to Ca content, the CO_2 can increase Mg in groundwater upto 190 mg/l. In groundwater, the Ca content generally exceeds the Mg content in accordance with their relative abudance in rocks. General concentration of Mg is less than 50 mg/l in groundwaters, but in brines, it contains as much as 57,000 mg/l.

Na : Na-bearing minerals like albite and plagioclase, clay minerals, evaporites (halite), and urban as well as industrial wastes, and sea water (saline water) are the major sources of Na in groundwaters. Base exchange of Ca by Na is also one of the source for increase of Na in groundwaters. Since most Na-salts are readily soluble, they tend to remain in solution unless extracted during evaporation. The Na content in groundwater ranges from 1 to 200 mg/l, though connate water may have as much as 10,000 to 100,000 mg/l of Na. Industrial and urban waste waters increase the content of Na in groundwaters.

K : The common sources of K are feldspars (orthoclase and micro-cline), potash fertilisers, feldspathoids, some micas and clay minerals. Although K is nearly as abundant as Na in minerals of earth's crust. It is also less abundant than Na. Two factors are responsible for this phenomena - one being the resistance of K-minerals to decomposition by weathering and the other fixation of K in clay minerals formed due to weathering. In groundwaters, its concentration is usually 10 mg/l and seldom exceeds 15 mg/l. Thermal and brine waters contain as much as 100 and 25,000 mg/l respectively.

CO_3 and HCO_3 : The primary source of CO_3 and HCO_3 ions in groundwater is due to the dissolved CO_2 in water. Decay of organic matter in the soil releases CO_2 for dissolution. Water charged with CO_2 dissolves the carbonate minerals to give HCO_3. The pH of the water indicates the form in which the CO_2 is present. The presence of carbonic acid is indicated, when the pH is less than 4.5, HCO_3 if the pH is between 4.5 and 8.2 and CO_3 if the pH is over 8.2. In groundwaters, the concentration of CO_3 generally does not exceed 10 mg/l. But in waters high in Na it may go upto 50 mg/l. Groundwaters normally contain HCO_3 in the range of 250 to 500 mg/l.

Cl : The content is generally low in rocks. Groundwater gets its Cl from the ocean through sprays trapped into raindrops. Other sources of Cl in groundwaters are evaporite deposits, hot springs, volcanic gases, connate water, clay material, urban, agricultural and industrial wastes, desert areas and coastal areas. The concentration of Cl in groundwater is commonly less than 10 mg/l in humid regions, and is more than 1000 mg/l in arid regions.

SO_4 : It is abudant in groundwaters due to oxidation of sulphide ores, atmospheric precipitation, water passes through lignite, coal and gypsiferous beds, and low precipitation, inadequate drainage conditions areas of mining activities, industrial wastes and application of sulphatic soil conditions. The SO_4 content in groundwater is less than 300 mg/l except in wells influenced by acid mine drainage. As much as 200,000 mg/l of SO_4 is in areas of brines.

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NO_3 : No_3 in groundwater is derived from plants or sewage. Some plants fix atmospheric nitrogen and form nitrates. Manure, cesspools, urban wastes (septic tanks and sewage waters) etc., contain organic nitrogen. NO_3 in normal groundwaters is less than 10 mg/l, but polluted water contains upto 100 mg/l or more. In arid regions, it may attain very high NO_3 content.

F : Fluorite, apatite, hornblende, micas and clays are the major contributors of F in the groundwaters. The concentration of F in groundwaters is limited due to low solubility of its source material. Groundwater contains F generally less than 1 mg/l, but in some areas the concentration reaches above 5 mg/l.

Trace elements : These elements include silica (SiO2), iron (Fe), manganese (Mn), boron (B), arsenic (Ar), barium (Ba), beryllium (Be), bismuth (Bs), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), nickel (Ni), selenium (Sn), strontium (Sr), tin (Tn), titanium (Ti) and zinc (Zn). Generally, they are not exceeding 1 mg/l. However, higher content of Zn, Cu and Pb can be found in mine waters, having low pH. Similarly, Zn, As and Pb are associated with ore-bodies and Cr, Cu, Pb, Cd, Ar and tin may occur through industrial disposal.

The chief sources of **silica** in groundwaters are quartz, feldspars, feldspthoids, amphiboles, pyroxenes, mica, clay, opal and chert minerals. Besides, hot spring and brine areas are also sources for more content of SiO_2 in groundwaters. Groundwaters generally contain 1 to 30 mg/l of silica, though upto 100 mg/l is fairly common.

Fe-bearing minerals (phyroxenes, amphiboles, micas, pyrite, chalcopyrite, sandstone, shale and limestones contain very small content of Fe as cementing material. It is controlled by presence of CO_2 and pH. Generally, it is less than 0.5 mg/l. But the influence of acid waters derived from thermal springs, mines and industries, it is as much as 6000 mg/l.

The principal sources of **Mn** in groundwaters are soils and sediments in addition to metamorphic and sedimentary rocks, mica-biotite and amphibole hornblende minerals. Generally, it occurs in groundwaters much less than Fe. Normally, it is less than 0.2 mg/l in groundwaters. But the acid mine water, industrial effluents may increase the Mn more than 10 mg/l.

Tourmaline, borox, kernite, evaporate deposits and hot springs and geyers are the source of **boron** in waters. Usually, it occurs from insignificant to 10 mg/l.

Radionuclides : These are unstable nuclides that tend to decay to other species of nuclides and are measured in microcuries (μc). Uranium (U^{235} and U^{232}) is present in groundwaters generally in the range of 0.00005 to 0.0001 mg/l. Radium (Ra^{230}) is normally less than 10^{-2} μc/ml. Radon (Rn^{232}) is usually less than 3×10^{-5} μc/ml. Tritium (H^3) ranges between 1 to 10 tritium units (TU), each unit producing roughly 3.2×10^{-9} μc/ml activity.

Dissolved Gases : Most groundwaters contain dissolved gases derived from natural sources. Those involved in the normal geochemical cycle of groundwater include the atmospheric gases - carbon dioxide (CO_2), oxygen (O) and nitrogen (N_2). Other derived from underground biochemical processes include the flammable gases - methane (CH_4) and hydrogen sulfide (H_2S). The solubility of gases varies directly with pressure and inversely with temperature.

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21.3.3. Biological Impurities

Bacteria and micro-organisms present in water are too small to be seen by the naked eye. Some of the bacteria are harmless, while some are disease-causing, known as pathogenic bacteria. Coliforms, which are present in the intestine of human beings and other warm-blooded animals, are transmitted through fecal matter. Although coliforms are harmless, their presence in groundwater indicates the possibility of the presence of pathogenic bacteria.

An indirect index of the presence of organic matter in the water is the **Biochemical Oxygen Demand** (BOD), which is the amount of oxygen required to cause biological decomposition of organic matter and waste. When oxidation is complete and no oxygen is required, BOD is zero.

Generally, the groundwater is free of pathogenic organisms unless polluted by surface drainage. The organisms are reported as the most probable number (MPN) in a given volume of water.

Check Your Progress - 1 & 2

1. What are the physical parameters of water ?
2. Write about TH classification of water ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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21.4. ENVIRONMENTAL PROBLEMS

Environmental problems have been evaluated based on the effects of quality of groundwater on human health, irrigation lands and industrial sector in the following lines.

21.4.1. Human Health

Groundwater to be used for drinking and domestic purpose should be free from the undesirable physical parameters such as colour, odour and taste; temperature and turbidity. For public water supply, the colour on cobalt scale (units) should not exceeds 50 and should be preferably less than 5 (Table 21.1). Otherwise, it spoils the clothes. Similarly, odour and taste make the water unpleasant for drinking. The desirable limit for drinking water is 10 JTU units and maximum turbidity limit is 25 JTU units. If the water exceeds these limits, it is aesthetically unattractive and is also harmful to the consumers. The desirable temperature of potable water is 10°C, while

the temperature of 25°C is considered to be objectionable. It may be helpful in detecting the unsuspected source of pollution.

pH has no direct effect on the human health. However, all biochemical reactions are sensitive to the variation of pH. For most reactions as well as for human beings, pH value of 7 is considered to be the best and the most ideal. The limit for pH value for drinking use is, however, specified at 6.5 to 8.5 (Table 21.1).

Water with high TDS is generally less palatable and may induce an unfavourable physiological reaction in the transient consumer. However, more mineralised water is also used where better water is not available. For this reason, 500 mg/l as the desirable limit and 1500 mg/l as the maximum permissible limit has been suggested for drinking purpose, when alternative source is not available (Table 21.1).

Table 21.1 Quality criteria for drinking purpose.

Constituent or Property	Highest desirable limit	Maximum permissible limit
Physical parameters		
Colour (Hazaen units)	5	10
Taste and odour	- Unobjectionable	-
Turbidity (JTU units)	10	25
Chemical parameters		
pH	7-8.5	6.5-9.2
TDS (mg/l)	500	1500
TH as $CaCO_3$ (mg/l)	300	600
Ca (mg/l)	75	200
Mg (mg/l)	30	100
Na (mg/l)	200	-
Cl (mg/l)	250	1000
SO_4 (mg/l)	150	400
F (mg/l)	0.6	1.2
NO_3 (mg/l)	45	-
Fe (mg/l)	0.3	1.0
Cu (mg/l)	0.05	1.5
Zn (mg/l)	5	15
As (mg/l)	0.05	-
Hg (mg/l)	0.001	-
Cd (mg/l)	0.01	-
Cr (mg/l)	0.05	-
CN (mg/l)	0.05	-
Pb (mg/l)	0.05	-
Se (mg/l)	0.01	-
Ba (mg/l)	-	1.0
Ag (mg/l)	-	0.05
BOD (mg/l)	9.51	9.20
Biological parameters		
10 ml standard portions	-	Not more than 10% in any month shall show the presence of the coliform group.
100 ml standard portions	-	Not more than 60% in any month shall show the presence of the coliform group.

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The **TH** of water is characterised by content of Ca or Mg or both. The contents of Ca and Mg in potable water ranges from 75-200 mg/l and 30-100 mg/l respectively. The safe limit of TH in water is 300 mg/l (Table 21.1). The excess TH in water is therefore undesirable. It causes more consumption of soap, affects the working of dying system, produces scales on boilers, causes corrosion and incrustation of pipes and makes food tasteless. Maximum permissible limit is 600 mg/l.

The content of **Cl** imparts salty taste to water. For people, who are not accustomed to high Cl in water are subjected to laxative effect. For drinking water, the highest desirable level of Cl is 250 mg/l and its maximum permissible level is 1000 mg/l (Table 21.1).

The **Na** concentration in drinking water should not be more than 200 mg/l. Other wise, it causes hypertension.

Na and **Mg** sulphate salts exert a cathartic action on human beings. It is also associated with respiratory diseases. Thus, the recommended content of SO_4 in potable water is limited to 150-400 mg/l (Table 21.1).

The concentration of NO_3 in groundwater should not exceed 45 mg/l (Table 21.1). High NO_3 levels in drinking water have been reported to be responsible for prevalence of methemoglobinemia or blue baby syndrome in infants.

The **F** content is important in human nutrition for the normal development of bones. Hence, it should not exceed 1.2 mg/l in potable water (Table 21.1). The content of F with less than 0.6 mg/l indicate the desirability of fluoridation of the water supplied to prevent the dental decay. If it is in excess of 1.2 mg/l, it will cause serious dental disorder, i.e. bone flourosis.

With increased temperature, there is a decreased solubility of oxygen in the water, which cause a significant oxygen deficit.

The effects of dissolved trace elements in water on human health are shown in Table 21.2.

Table 21.2 Diseases associated with dissolved constituents at large doses

Chemical constituents		Diseases
Arsenic	:	Dark skin, loss of hair, gastroenteritis, nasal irritation.
Barium	:	Thyroid disease, hypertension, arteriosclerosis.
Boron	:	Brain damage, fever.
Cadmium	:	Hypertension, emphysema, osteoporasis, testicle cancer, coronary heart disease, kidney disease.
Chromium	:	Nasal irritation, nose cancer, dermatist.
Cobalt	:	Thyroid disease, asthma, myocardial disease, fibrosis of lungs.
Iron	:	Siderosis, fibrosis of lungs.
Lead	:	Anemia, gastrointestinal systems, encephalopathy, loss of hair, brain involvement, kidney disease, ataxia.

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Manganese	:	Ataxia, tremor, fever.
Mercury	:	Fine tremor, loss of memory, paranoia, ataxia, brain involvment, kidney disease.
Molybdenum	:	Anemia, liver disease.
Nickel	:	Nasal irritation, abdomen cancer, dermatitis.
Silica	:	Silicosis, fibrosis of lungs.
Selenium	:	Odor of garlic, teeth decay, nose cancer, kidney disease, liver disease, visual reduction.
Strontium	:	Bone diseases, bone and nose cancer.
Tellurium	:	Garlic like odour.
Titanium	:	Yellow discoloration of skin.
Vanadium	:	Respiratory systems.
Zinc	:	Fever, brain involvement, gastroenteritis.

Water containing as little as 1 to 2 mg/l of methane can produce an explosion in a poorly ventilated air space. Fires and explosions in well pits, basements, and water tanks have occurred from methane emitted by groundwater. The danger exists when the people went into the dugwells and pump pits where high methane concentrations form. The hydrogen sulphide gives disagreeable odour to water even if its amount is very small. The CO_2 content indicates biological activity and causes corrosion, increases solubility of many minerals in water and gives taste to the water.

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Dissolved Oxygen (DO) hastens the corrosive action of water on steel, iron and galvanished iron and brass. In drinking water, the value of BOD should ideally be nil. The DO sustains life within the water and its depletion has adverse effects on the health and survival of aquatic life. The discharge from affluent contributes greatly to the organic content of water and thus increase the BOD, which makes unfit for organisms.

The hazards of radiation in human beings are acute damage (sudden death, death after 2 or 3 weeks, loss of hair, widespread ulcers, bleeding from the mount and gums, inability to deal with even minor infections etc., chronic damage (blood diseases including leukemia and anemia, cancer of the skin and other organs, cataracts, somatic mutations, life-span shortening etc. and genetic damage (changes in future generation). The permissible limits of radio-nuclides are as follows :-

Radium	:	0.4 μμC/l
Other alpha-emitters	:	2.4 μμC/l
Radio stronium and Radio calcium	:	20 μμC/l
Other beta-emitters	:	1000 μμC/l

Note : μμC/l = One millionth of a millionth of Curie per litre or micro-microcurie per litre.

21.4.2. Irrigation lands

The most important factors, which affect the water quality for irrigation are a) the total concentration of soluble salts, b) the relative proportion of Na to Ca and Mg and c) concentration of boron, Cl, SO_4 and HCO_3.

The TDS, expressed in terms of EC (Electrical Conductivity), and relative proportion of Na to Ca and Mg expressed as SAR (Sodium-adsorption ratio), forms the basis of a classification of water for irrigation use. The salinity hazard (TDS or EC) increases as the soils become fine gained and aridity increases, resulting in the concentration of salts in the soil that may require periodical leaching. A list of crops showing their relative tolerance to salt content is given in Table 21.3.

Table 21.3 Relative tolerance of crops to salt concentration

Sensitive	Semi-tolerant	Tolerant
Arhar	Apple	Barley
Gram	Banana	Cotton
Moong	Cabbage	Sugar beet
Peas	Guava	Sugar cane
Jowar	Sarson	
Karela	Tobacco	
Lemon		
Maise		
Mango		
Onion		
Orange		
Pear		
Potato		
Rice		
Tomato		
Wheat		

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Excessive Na content in water renders it unsuitable for soils containing exchangeable Ca and Mg ions. The exchange capacity of water is expressed by SAR.

$$SAR = \frac{Na}{\sqrt{Ca + Mg/2}}$$

Water with high Na content may create to decrease permeability of soils and requires special water and soil management practices like application of gypsum, organic manures, lime etc.

Boron is necessary in very small quantities for normal growth of all plants, but in large concentrations it becomes toxic. Quantities needed vary with the crop type; sensitive crops require minimum amounts whereas tolerant crops will make maximum growth on several times. With high in HCO_3 and Cl ions are known to be hazardous for

irrigation. Therefore, the prescribed safe limits of these ions in waters are 200 and 150 mg/l respectively.

21.4.3. Industrial sector

Groundwater quality criteria for industrial purpose vary widely. Thus, make up water for high pressure boilers must meet exact criteria, water of as low quality as sea water can also be satisfactorily employed for cooling of condensers. Even within each industry, criteria cannot be established, instead, only recommended limiting values or ranges can be stated. Salinity, TH and silica are three parameters, which are normally important for industrial water.

Check Your Progress 3 & 4

3. What is the desirable limit and maximum permissible limit for total dissolved solids (TDS) ?
4. What are the three important factors for industrial use of water ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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21.5. TREATMENT OF GROUNDWATER

The water required for public water supply schemes should be potable. It is, however, not essential to have physically or chemically pure water. The presence of some minerals in water is required to give some taste to water and they also assist in food assimilation. However, such dissolved constituents in water should not be more than the required concentrations. If they are present, they can impair the use of water and can create hazards to public health through toxicity or the spread of the disease.

Having examined the quality of water, a line of treatment is to be recommended for impure water to make it potable purpose. Treatment methods include sedimentation, coagulation, filtration, disinfection, water softening and miscellaneous procedures.

Sedimentation The first stage of treatment is the prefiltration of water and it includes provision of sedimentation tanks or settling tanks or classifiers. These tanks remove inorganic impurities and make water fit for the next process of filtration.

Coagulation It is to make particles of bigger size by adding certain chemicals (aluminimum sulphate, chlorinated coppers, ferrous sulphate and lime, magnesium carbonate, polyelectrolytes and sodium aluminate) known as coagulants to water. The coagulants make the impurities in water and convert them into settleable size.

Filtration The process of filtration forms the most important stage in purification of water. It usually consists in allowing water to pass through a thick layer of sand. It

removes suspended and colloidal impurities, alters chemical characteristics of water and reduces number of bacteria.

Disinfection When water leaves the filter point, it is still found so contain some of the impurities such as bacteria, dissolved inorganic salts, colour, odour and taste, and iron and manganese. This process is to prevent contamination of water during its transit from the treatment plant to the place of its consumption. For treatment on small scale, boiling method and excess lime treatments are generally used. For treatment on large scale, chlorination is usually adopting method.

Water softening The TH of water is softened by two methods : a) boiling or adding lime and b) lime-soda, zeolite and demineralization. The first procedure is applied for removal of temporary hardness, while the second methods are used for removal of permanent hardness.

Miscellaneous methods

a) Sorption It serves as a major procedure for reducing groundwater pollution. Clays, metallic oxides and hydroxides and organic matter function as sorptive materials.

b) Chemical Processes Chemical precipitation becomes a major attenuation mechanism in arid regions where moisture in the near surface zone is minimum. Similarly, in the zone above the water table, oxidation of organic matter acts as an important attenuation process as complex organic compounds are oxidised stepwise to more simple organic compounds until CO_2 and H_2O are formed along with numerous inorganic ions and compounds. Both oxidation and reduction reactions can occur underground in conjunction with other mechanisms, leading to precipitates, deposits of insoluble trace elements and gases. Radioactive decay, based on the half-life of a radioisotope, acts as reduction method for radioactive pollutants.

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c) Microbiological Decomposition Most pathogenic micro-organisms in the soil do not flourish in the soil and hence are subject to ultimate destruction. Bacteria and viruses as particulate matter suspended in water tend to move slower through a porous media. They are largely removed by passing through as little as one metre of soil, provided reasonable amounts of silt and clay are present.

d) Dilution Impurities in water flowing through porous media tend to become diluted in concentration due to hydrodynamic dispersion occurring on both microscopic and macroscopic scales. These mixing mechanisms produce a longitudinal and lateral spreading of salts within the groundwater so that the volume affected increases and the concentration decreases with distance traveled. It is the most important reduction process for salts after they reach the water table.

e) Aeration For removal of colour and odour and taste, aeration process is adopted. It brings water in intimate contact with air. In this process, oxygen is absorbed by water and CO_2 is liberated. It removes H_2S and bacteria. The Fe and Mn are also oxidized to certain extent by aeration process.

f) Activated carbon It is used to remove colour, odour and taste from water and is a form of charcoal or vegetable carbon, which is activated or oxidized by passing air or stream. It removes the hydrocarbons that might interfere with the adsorption of organic matter.

g) Defluoridation : This process is used to remove excess F in the water. There are so many methods to remove F in the water. They are i) activated carbon ii) lime-soda iii) calcium phosphate, iv) bone charcoal v) synthetic tricalcium phosphate and vi) filter beds containing F retaining materials. Most of them suffer from one or the other disadvantages such as high initial cost, expensive regeneration, poor F removal capacity etc.

To overcome all these drawbacks, a new technique known as **"Nalgonda Technique"** has been successfully applied. In this method, Na-aluminate or lime, bleaching powder and filter-alum are added to F-water in sequence. Water is then stirred for 10 minutes and settled for 1 hour and water in then withdrawn without disturbing the sediments. Na-aluminate or lime aceclerates settlement of precipitate and bleaching powder ensures disinfection. The alum dose required will depend upon the content of F and TA.

Check Your Progress 5 & 6

5. Name some of the treatment process of groundwater ?
6. What is Nalgonda technique ?

Note : (a) Write your answers in the space given below.

(b) Compare your answer with the model answer given at the end of the unit.

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21.6. SUMMARY

In general groundwater contains some salts derived from the location and past movement of water. For the usage of groundwater the salts or elements must be under limits, if the content of any element exceeds this limit, environmental problems will develop. The type and concentration of salts in water depends on the environment, past movement and source of groundwater. The elements present in groundwater are called as dissolved constituents and are classified as physical, chemical and biological parameters.

Physical parameters for the quality of groundwater are the colour, odour, taste, turbidity and temperatures. Colour is due to the presence of iron and organic matter. Odour and taste will result due to the presence of dissolved gases and mineral matter. Turbidity is measure of the presence of clay, salt, organic matter etc. groundwater have

a temperature of 10°C, if the temperature is more, it is helpful to know the source of pollution.

The chemical parameters of groundwater quality are the hydrogen - ion concentration (PH), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH) calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), carbonate (CO3), bicarbonate (HCO_3), chloride (Cl), sulphate (SO_4), nitrate (NO_3) and fluoride (F). Dissolved gases like CO_2, O, N_2, CH_4, H_2S etc. and trace elements like Mn, B, Ar, Ba, Be, Bs, Cd, Cr, Co, Cu, Pb, Ni, Sn, Sr, Tn, Ti and Zn are also comes under chemical parameters.

Environmental problems will be evaluated based on the quality of groundwater for different purposes. The main purposes are the drinking, irrigation and industrial sectors. For drinking purpose the standard levels are in between PH is 7-8.5, TDS is 500-1500, Ca is 75-200, Mg is 30-100, Na is 200, Cl is 250-1000, SO_4 is 150-400, F is 0.6 to 1.2, NO_3 is 45-100. All the above volumes are milligrams per litre. If the water contains more value for any of the elements the health problems will develop.

For irrigation purpose the impart element to be considered for safer usage are the Na, Ca, Mg, K, Boran, Cl, SO_4 and HCO_3. All these elements must be under control in their quantity in water.

For industrial purposes no criteria has been established, but for safer usage the drinking water standards are applicable.

The water required for public supply should be potable. It is however not essential to have physically or chemically pure. The presence of some minerals are essential to get taste and for easy assimilation of food materials. If the dissolved salts are more than the required concentrations, then the water required treatment processes. Treatment processes involves, sedimentation, coagulation, filteration, disinfection, chlorination, water softening etc.

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Sedimentation is a process in which the water is stored in large tanks to settle down impurities before filteration. Coagulation is the process to make the unwanted particle size to bigger by adding some other material. The bigger particles immediately settlesdown. Filteration is process of passing water through filterbeds to remove impurities. Disinfection process controls the pathogenic microorganisms by boiling, lime treatment and chlorination. Water softening is useful to change hardwater into softwater. Dilution, aeration, activated carbon treatment, deflouridation are the other methods of treatment. Nalgonda technique of deflouridation is famous for removing excess fluoride from waters.

21.7. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The physical parameters of groundwater quality are the colour, taste, odour, turbidity and temperature.

2. TH classification is if the waters have less than 75 TH they are called soft, in between 75-150 they are moderately hard, in between 150-300 they are hard, more than 300 mg/l then very hard.

3. The desirable limit for TDS is 500 mg/l and the maximum permissible limit is 1500 mg/l.

4. Salinity, total hardness and silica are the three impart factors for industrial use.

5. Sedimentation, coagulation, filteration, Disinfection, chlorination, water softening, dilution, chemical process, micro biological decomposition, aeration, activated carbon method, deflouridation are the treatment process of groundwater.

6. Nalgonda technique is processes of diflouridation, in which Na-aluminate or lime bleaching powder and filter alum is added to ground water and stirred to remove the effect of excess fluoride.

21.8. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in 30 lines.

1) Explain the physical properties of groundwater quality.

2) Give an account of the sources of dissolved chemical constituents in groundwaters.

3) Describe the impact of groundwater quality on human health.

4) What are the methods we have applied for treatment of groundwater .

II. Answer the following questions in 10 lines each.

1) Explain the sources of biological impurities in groundwater.

2) Give a brief account of the groundwater quality on irrigation lands.

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Dr. N. Subba Rao

UNIT-22: ENVIRONMENTAL POLICY AND LAW

Contents

22.1. Objectives
22.2. Introduction
22.3. Environmental Planning
22.4. Landuse Policies
22.5. National Environmental Act of 1986
22.6. Mining Law
22.7. Water Law
22.8. Land Use Law
22.9. Summary
22.10. Check Your Progress : Model Answers
22.11. Model Examination Questions

22.1. OBJECTIVES

By the end of this unit, you will be able to :

* explain the environmental planning, problems and conflicts,
* describe the land use policies,
* explain National Environmental act of 1986,
* define Mining law, water law and land use law.

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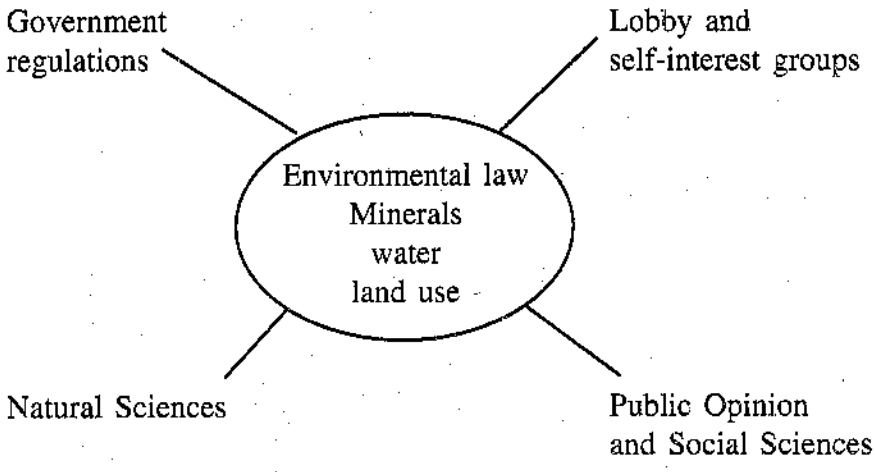
22.2. INTRODUCTION

The processes of urbanisation and Industrialization is polluting the human environment. The environmental policies and laws are essential to overcome environmental hazards. Environmental policy comprises the operational mandate that is prescribed, and guides the planning and management of human affairs. Policies are therefore a resultant vector that is set in motion by the selection of a particular frame work of action. As the environment belongs to all people there are always multiple constituencies involved in matters dealing with the earth's land - water ecosystem. In the final analysis, environmental policy becomes the prerogative of governments and is institutionalised through legislation and jurisdiction.

Environmental law became popular from the late 1960's. Law consists of societal rules established by the governing authorities. Common law consists of a wide range of legislative statutes, ordinances, agency regulations and codified directions of recognised public officials. The establishment of the common law is developed through custom and tradition, and its guidelines and limits of power have been formulated through action in the courts and the judicial decisions pertaining to this actions. It has been said that the best laws are those that are in tune with the times. Environmental law is now being interpreted to cover an extremely wide range of human behavior and actions.

The modern clean water, clear air, and land use laws exhibit the continuing growth and sophistication of human behavioral patterns and reflects a new attitude toward nature. The character of environmental law influenced by different constituencies.



Recall the environmental protection laws given in **Block V of course I Ecology, Environment and development**. Therefore you are advised to go through those units before starting this unit.

22.3. ENVIRONMENTAL PLANNING

Environmental planning, policies, and management are intimately related. The purpose for establishing environmental policy is to set a course of action in which it is hoped the number of conflicts will be minimised and the environmental impacts will be reduced, both to society and to natural systems. This is accomplished by providing a planning and assessment base where in alternative actions have been considered and both short-term and long-term effects of the projects determined. Such evaluation will aid to subdue adversely militancy and enhance the management phase by securing necessary funding and legal support. Policy making may not be 100 percent scientific, neither will a given policy please all the people all the times. Vital decisions will always ultimately depend on the perception of the problem and on the values that are perceived and how they are expressed through the political-legal system. Definition of the problem is prerequisite to planning, regardless of whether the decision maker is an individual or a group. We can define a problem in terms of

1. **Objectives :** Those goals that are to be achieved or those values that are to be maintained.
2. **Alternatives :** Those options that also need scrutiny to determine the most effective course of action.
3. **Environmental Setting :** Those factors that will be involved because of the action. This includes not only the narrow confines of the specific action, but its relationship to the greater arena of social, economic, political and biophysical systems that will be affected. No longer can proposed projects be considered in isolation from other dimensions of the human scene.

Without all three of these components there is no problem to solve, no decision to be made, and consequently no plan to be formulated. The character and effectiveness of

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environmental planning affects the quality of life. However, too often planners must function with in jurisdictional boundary lines that are artificial in terms of natural systems. To cope with such difficult odds and other constraints that circumscribe solutions requires unusual analytical tools and multi disciplinary efforts with the decision makers.

Problems and conflicts : Should phreatophytes be eradicated to save groundwater at the expense of voluble wild life habitats ? Should a community deliberately restrain its growth in order to possess more open space ? Should a wild river be dammed to provide a water supply for new consumers ? should costly antipollution devices and abetments be required of an industry that may loose its competitive edge and thereby cause wide spread un employment ? These and many questions like them must be solved by environmental planning. Such questions have one common theme - they pose problems of evaluation where in comparisons must be made between alternative actions. How to judge the severity of the environmental impact and how to relate it to some type of benefit cost analysis become exercises in the assignment of values, risk and economics. There is a wide gap between scientists and lay citizens in their comprehension of environmental processes, hazards and resources, similar situation prevailed between the scientists and planners also. A typical planner may be so heavily burdened with day to day operational matters that there is insufficient time to keep upto date on environmental data. Planners, further more, must deal with a set of variables that may not be internally consistent. They must develop the project in terms that are technically possible, economically feasible, socially and politically acceptable and legally un impeachable. Unfortunately, the environmental world is one of complex interactions and decision makers may not have the time, patience, or training to understand the relationship that exist among the integral parts of an Ecosystem - the resources, the energy the waste, and the land use aspects of the natural - human biosphere. So Environmental planners must consider all aspects of human - nature concern at the time of planning.

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22.4. LAND USE POLICIES

Land use is a unit of the land scape that can be categorised by its state of existence or management. The way in which a part of the landscape serves a functional purpose for example, for the mining of natural resources defines its land use. **Land scape** values are determined by groups or individuals. Resource allocation is a non-issue if deemed valueless or unimportant by decision makers. **Land scape assessment** is the method by which land scape values are estimated. Historically land use planning and control were largely concerned with land as an economic and cultural entity. Natural environment processes received scat attention as means of differentiating one parcel from another. Policies were made in utilitarian terms, considering only the ability of land to accommodate man made structures.

Most policies that now deal with land use and its landscape setting make some attempt to account for.

1. Air and water properties which are fluid and flow through the entire ecosystem occupied by humans.

2. Processes that create threats to life and property.

3. Loss of soil and mineral resources.

4. Those landscape elements that needs protection in their own right, yet which may be in danger due to possible development.

Thus land is recognised as constituting both a commodity and a resource. Further more land use policies have largely become governmental and public matters because of the extensive power that governments would in its control.

Check Your Progress 1 & 2

1. What is the purpose of Environmental Planning ?
2. Define land use ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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22.5. NATIONAL ENVIRONMENTAL ACT OF 1986

Article 51-A in Indian constitution provides that it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for all living creatures.

The National Environmental act of 1986 was already discussed in course I unit 18. for quick reference again discussing here for learners convenience.

To create public awareness through legislation, it is essential that there must be sufficient social litigation amongst the society with good number of complaints against the polluters, to keep an effective check against environmental pollution. With this in view the latest act, the Environment act 1986 empowers the citizens to file a suit against the polluting units for compensation.

It recognises the fact that pollution control is different from protection and taken into consideration such vast variety of problems ranging from urbanisation, congestion, housing, growth of slums, sanitation, disposal of garbage and the exhausts arising out of automobiles. The Environment Protection Act even deals with population policy and industrial policy in addition to modes of transport and housing that are inter-twined with environment. Though there is some over-lapping of what has been provided in the Air and Water (Prevention of Pollution) Acts, punishment and retribution have been given a lower priority compared to public participation in raising the awareness of the society and creating the necessary infrastructure to ensure environmental protection. It has broad-based purview of environment including every aspect of modern life such as housing, water-supply, landuse, urban migration and use of fertilizers and pesticides. Thus, for the first time a comprehensive legislation has

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been attempted, providing the law-enforcing agencies the necessary clues to succeed in the sphere of environmental enrichment. Mere enforcement through levying fines and jail terms can not go far in the field of protecting the environment. A basic understanding of the average human psyche and an empathetic attitude towards ignorance and compulsions of average citizen are needed. On the other hand it vests such wide powers as closing the industrial units that are harmful to public safety. Certain lacunae left in the act have been rectified in the Tribunals Act of 1992.

22.6. MINING LAW

Mining is the second largest industry after agriculture. Most valuable materials for man such as metals, chemicals, fuel for energy, rocks and stones for buildings come from mining. With the rapid rise in human population and developmental activities, mining has expanded by leaps and bounds and a great threat is caused to the environment. Mining is a very long and complex process and involves several steps between sampling of mineral ores to concentration and excavation of final products. This leads to a variety of environmental problems. The degradation begins with extraction of mineral resulting inland degradation and further the air and water pollution is caused till the final product is avoilable.

The mines act (35 of 1952) was promulgated on 15th march 1952 and came into force in 1st July 1952. As per the act any thing dug out of earth surface of economic importance is a mineral and the govt has full rights on such resources. As per the mineral policy 1994. Some minerals were kept under central government control and remaining were kept under respective states control. For some strategic minerals government is conducting the mining operations on its own. For remaining minerals government is permitting private companies by collecting mining cess.

The mines act (1952) has made some provisions to safe guard the environment, health and safety of the mine workers. Those are

1. Provision for good drinking water
2. Provision for conservancy - separate latrines for males & females in every mine.
3. Medical applicances in every mine at accessible area.
4. Inpectors supervision regarding safety.
5. Notice to be given of accidents.
6. Power of government to appoint court of enquiry in case of accidents.
7. Notice of certain diseases.
8. Power to direct investigation of cause of disease.
9. Publication of detailed report.

22.7. WATER LAW

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There are some differences in laws that govern use of surface water when compared to groundwater use. Water law is still being refined by the courts and many cases are decided on a case by case base.

The right to use the water of a stream accompanies ownership of land adjacent to the streams. However the owner of the land cannot sell or export water for use elsewhere. In our country the local bodies, the panchayats having powers on the local lakes, ponds etc.

Legal affairs dealing with surface water are less dispute than those relating to groundwater. Because the amount and movement of groundwater are hidden from view, there is more mystery and ambiguity, concerning its ownership. However, groundwater usage, as in surface water was judged in terms of whether it was reasonable and beneficial.

The government of India has prepared a model bill regarding groundwater called groundwater (control and regulation) act of 1992. This act; was circulated to all states and union territories for framing independent acts as groundwater comes under states subject as per entry 17 of List II of the seventh schedule of constitution of India.

Based on the above act the government of Andhra Pradesh prepared and passed in the legislature the act No. 7 of 1996 on 7th February 1996. This act is named as Andhra Pradesh ground water (Regulations for drinking water purpose) act 1996. This was made into 15 points.

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1. **This is regarding the title of the act.** The act will be termed as Andhra Pradesh ground water Act. 1996.

2. **This point explains about the definitions of different terminology used in the act.**

3. **Third point deals with license to dig wells.**

This explains no person (person does not include government) shall sink any well for any purpose in the visinity of a public drinking water source with in a distance of 200 mts if it is source for open well or hand pump and with in a distance of 250mts for power driven pump. If any body wants to sink a well he has to get prior permission by applying to the appropriate authority in such manner and on payment of such fees as may be prescribed. After examining the case the Hydrogeologist or geophysicist may accord permission for any type of well for any purpose. If the authority fails to intimate the decision with in 90 days after applying automatically the person is eligible to sink the well. Even after giving permission the authority (government) has full right to prohibit, extract or regulate groundwater usage by order.

4. **This point states the power to declare water scarcity areas of government.**

The authority (govt) with the advice of technical officer may declare any area to be water scarcity area. From such areas govt may restrict or regulate the wells which are with in one Km from the drinking water source. The order will valid for such period as may be specified in the order but not exceeding one year at a time.

5. **This point explains about Declaration of watershed as over exploitation.**

The government authority by examining the groundwater conditions may declare watershed as overexploitation. The authority has full right to stop, regulate prohibit the usage of groundwater from such declared watershed areas. If any person wants to sink a well he has to get permission from the government by paying fee as may be prescribed.

6. **This point states the prohibition of exploitation of water.**

The government authority may on the advise of technical officer declare the prohibition of exploitation of groundwater for other than drinking purpose from the watershed areas. The district collector will issue this order with the advise of technical officer from the 1st February to 31st July in an year. The authority may issue such order in urban areas, to prohibit extraction of water for sale from an overexploited water source, if it effects the public/private supply of domestic usage. Same time the authority may issue order to restrict the withdrawal of groundwater with in the premises of multi storeyed buildings for domestic usage with the advice of technical officer.

7. **This point deals with closure, disconnection etc of wells.**

Where ever it appears to the government authority that any well has been sunk or is being sunk against the above said rules, the authority or person authorised by it may enter upon that land, remove, obstruction if any close the pumping of the water, disconnect power supply, seize any material or equipment used in connection with such extraction of water.

8. **Payment of compensation is the important issue.**

Where an order of permanently closing down or sealing off the well which is giving substantial yield and which is really useful for irrigating for any land or for industrial use, the collector may on making such enquiry deem necessary, make and order for payment of compensation which shall not be less than the market value.

9. **Bar to claim compensation**

The rule states no person shall be entitled to claim any damage or compensation from the government for any loss to the motors, power supply during the implementation of this groundwater act.

10. **Appeals**

This rule provides opportunity to any person who may feel aggrieved by any order made by the appropriate authority under any of the provision of the act may, with in a period of 30 days from the date of receipt of order appeal to the collector or higher appellate authority.

11. **Protection of action taken in good faith.**

This rule states no suit or prosecution or other legal proceedings shall lie against any public servant or person appointed or authorised under this act by government.

12. **Offences and punishments**

Who ever contravences any of the provisions of this act or obstructs any person in the discharge of his duties under this act or contravences any order or violates any rule made under this act shall, on conviction be punished with imprisonment not be less

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than one month may extends to six months with fine which shall not be less than one thousand may extend upto five thousands or with both. The same punishment may applicable to persons who will damage, obstruct or alter the public water supply system.

13. **Service of Notice**

The order made under this act may be served either by tending or delivering a copy there of or by post to the person on whom it is served either by tendering or delivering a copy thereof or by post to whom the person authorised.

14. **Overriding effect**

This rule have effect not withstanding anything to the contrary contained in any other law for the time being in force.

15. **Power to make rules**

The government may by notification make rules for carrying out all or any of the purposes of this act. Every rule made under this act must be placed in legislative assembly.

Check Your Progress 3 & 4

3. When mining law 1952 was promulgated ?
4. What is the name of act prepared for groundwater by Andhra Pradesh ?

Note : (a) Write your answers in the space given below.

(b) Compare your answers with the model answers given at the end of this unit.

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22.8. LAND USE LAW

The mining law and water law discussed the legal aspect of resources when they are withdrawn from the earth. This land use law deals with the laws that effect the management of land. These mandated policies govern land utilisation by society, welfare and sustenance for our survival. There is a great variety of laws and legal actions that effect geologists in this area of land use and environmental management. Such policies set guide lines, provide funds and machinery for implementation and establish agencies for continuing planning and administration.

This land use law mainly deals with (a) water and soils (b) Forest lands and Range lands and (c) Parks and wildness.

The land provides ecological and environmental balance between land, water and ecosystem.

Check Your Progress 5

5. What is land use law ?

Note : (a) Write your answers in the space given below.

(b) Compare your answer with the model answer given at the end of the unit.

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22.9. SUMMARY

The process of urbanisation and industrialisation is causing pollution to the environment. So environmental policies and laws are essential to safe guard the environment. Environmental laws are the rules established by the governments. Best laws are those that are in tune with the times. The modern clean water, clear air, and land use laws reflects a new attitude towards nature. Environmental planning is prime important to avoid pollution. Planning, policies, and management are closely related.

Land use is a unit of the land scape that can be categorised by its state of existence. Landscape assessment is important to avoid land degradation. The government of India to create public awareness through legislation, and to check pollution promulgated the environment act of 1986 which empowers the citizens to file a suit against polluting unit for compensation.

Mining law as the mines act 1953 has made some provisions to safeguard the health, environment and safety of mine workers. Groundwater model law was prepared by govt of India and communicated to all states. The Andhra Pradesh government has made an act called Andhra Pradesh ground water act (Regulations for drinking water purposes) 1996. This gives powers to govt to check over environmental problem creators with groundwater. Land use law also provides some steps like maintenance of parks, forests areas etc. to avoid ecological imbalance.

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22.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The purpose of Environmental planning is the number of conflicts will be minimised and the environmental impacts will be reduced both the society and to natural systems.
2. Land use a unit of landscape that can be categorised by its state of existence and management.
3. The mining law of 1952 was promulgated on 15th march of 1952.
4. The Andhra Pradesh ground water, (regulations for drinking water purposes) act 1996.
5. The landuse law deals with the laws that effect management of land.

22.11. MODEL EXAMINATION QUESTIONS

I. Answer the following in about 30 lines

1. Write down about Environmental planning.
2. Explain the national Environmental act of 1986.
3. Write an essay about Andhra Pradesh state groundwater act 1996.

II. Answer the following in 10 lines.

1. Landuse Policies.
2. Mining Law
3. Landuse Law.

Dr. P. Madhusudhana Reddy

BRAOU

Reference Books

1. Environmental Geology - Indian Context by K.S. Valdiya
2. Environmental Geology - Donald, R. Coates
3. Environmental Geosciences - Strahlar & Strachler
4. Environmental Geology - A.E. Keller
5. Environmental Geology - C.W. Montgonery
6. Mining & Environment in India - Joshi & Battacharya
7. Groundwater Assessment, Development & Management - K.K. Karanth
8. Groundwater - H.M. Raghunath
9. Groundwater Hydrology - D.K. Todd
10. Soil Conditions & Plant Growth - Russel
11. Remote Sensing & Environment - Lentz, Simonett, Addisson & Reading Mass
12. Groundwater Hydrology - H. Bouwer
13. Environment & Health - M.N. Trieff
14. Foundamentals of Water Supply & Sanitary Engineering - S.C. Rangawala
15. A.P. Groundwater Act, 1996

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DR. B.R. AMBEDKAR OPEN UNIVERSITY
FACULTY OF SCIENCE
P.G. DIPLOMA IN ENVIRONMENTAL STUDIES
Course - IV : Environmental Geosciences

MODEL EXAMINATION PAPER

Time : 3 Hours | Max. Marks : 100

SECTION - A

4x15 = 60

Answer any **Four** of the following questions.
Each question carries 15 marks.
Answer in about 30 lines each.

1. Write about scope and objectives of Environmental Geosciences.
2. Describe the different types of pollutants in the atmosphere and their harmful effects.
3. Explain the different environmental impacts with earthquakes. Explain how to mitigate each impact.
4. Describe the possible solutions for minimising the impacts of mining on environment.
5. Explain in detail the quality of groundwaters and their suitability for drinking and irrigation purposes.
6. What are the environmental problems with dams and reservoirs and how to control it.
7. Describe in detail the environmental hazards with garbage dumps.
8. What are the available methods for treatment of polluted groundwater.

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SECTION - B

5x8 = 40

Answer any **Five** of the following questions.
Each question carries 8 marks.
Answer in about 10 lines each.

9. Explain A.P. Groundwater Act, 1996.
10. Explain briefly the sources and causes of urban pollution.
11. Describe the remote sensing applications in natural calamities.
12. Write briefly about geological classification of soils.
13. What are the environmental problems with tunnels.
14. What are suitable ground conditions for bridges.
15. Why the search for alternative resources are required.
16. What are causes for drought.
17. How volcanoes can be predicted.
18. What is green house effect.

DR. B.R. AMBEDKAR OPEN UNIVERSITY
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ASSIGNMENT - 1

Time : 2 Hours

Note :

1. *Do not copy the answer directly from any of the books.*
2. *As far as possible , try to answer the questions independently in your own words.*
3. *If it is necessary to quote from any source, give the correct reference.*
4. *Use your own foolscape pages for writing the assignment.*
5. *Leave sufficient margin for the comments of the evaluator.*
6. *Completion of this assignment normally should not take more than two hours time.*

BRAOU

I. Answer the following questions in about 30 lines each.

1. Write about the scope and objectives of Environmental Geosciences.
2. Write the origin, classification and occurrence of coal in India.
3. Write note on treatment of domestic and industrial waste water.

II. Answer the following in about 10 lines each.

1. What are the suitable ground conditions for tunnels.
2. What is green house effect.
3. Comment on pollution with fertilisers.

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Course - IV : Environmental Geosciences

ASSIGNMENT - 2

Time : 2 Hours

Note :

1. *Do not copy the answer directly from any of the books.*
2. *As far as possible , try to answer the questions independently in your own words.*
3. *If it is necessary to quote from any source, give the correct reference.*
4. *Use your own foolscape pages for writing the assignment.*
5. *Leave sufficient margin for the comments of the evaluator.*
6. *Completion of this assignment normally should not take more than two hours time.*

BRAOU

I. Answer the following questions in about 30 lines each.

1. Describe the impact of groundwater quality on human health.
2. Describe the Environmental impacts with volcanoes and earthquakes briefly.
3. What is the role of geologist in the development and technology.

II. Answer the following in about 10 lines each.

1. Briefly explain the environmental problems and remedies with roads.
2. What are the causes of floods.
3. Classify the different layers of atmosphere.

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ASSIGNMENT - 3

Time : 2 Hours

Note :

1. *Do not copy the answer directly from any of the books.*
2. *As far as possible , try to answer the questions independently in your own words.*
3. *If it is necessary to quote from any source, give the correct reference.*
4. *Use your own foolscape pages for writing the assignment.*
5. *Leave sufficient margin for the comments of the evaluator.*
6. *Completion of this assignment normally should not take more than two hours time.*

BRAOU

I. Answer the following questions in about 30 lines each.

1. Describe the different types of pollutants in the atmosphere and their harmful effects.
2. What are the environmental impacts with volcanoes. How to mitigate them.
3. Write an essay about Andhra Pradesh Groundwater Act, 1996.

II. Answer the following in about 10 lines each.

1. Explain land use policies.
2. What is green house effect.
3. Classify the soils.

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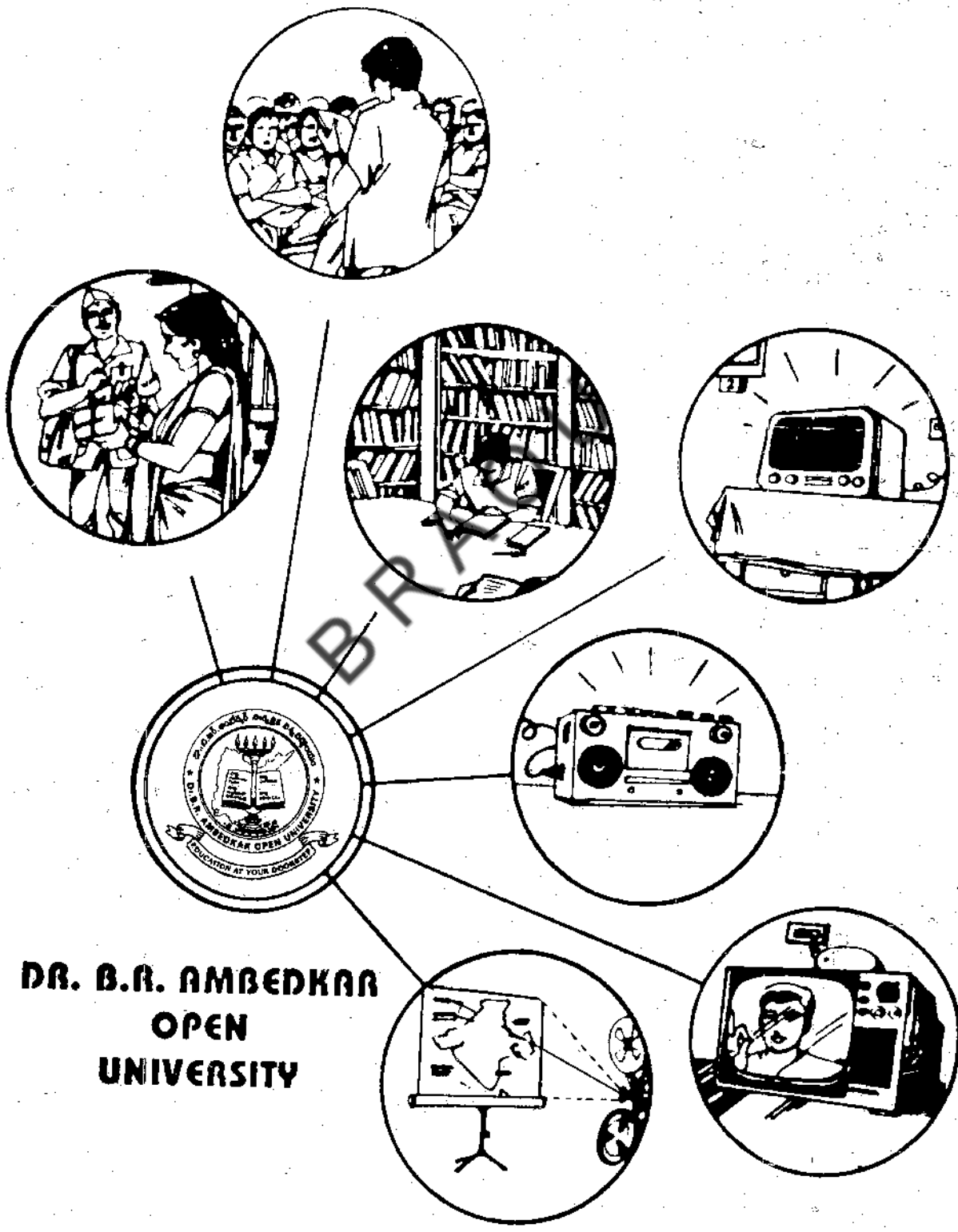

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PGDES - 4D

ENVIRONMENT : A SOCIAL SCIENCE PERSPECTIVE

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ENVIRONMENT
A SOCIAL SCIENCE PERSPECTIVE

BLOCK - 1	:	INTRODUCTION TO SOCIAL ENVIRONMENT
BLOCK - 2	:	ISSUES
BLOCK - 3	:	CHALLENGES - I
BLOCK - 4	:	CHALLENGES - II
BLOCK - 5	:	INSTITUTIONAL RESPONSE
BLOCK - 6	:	FUTURE

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Dr. B.R. AMBEDKAR OPEN UNIVERSITY
HYDERABAD
2003

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PREFACE

This book deals with "Environment : A Social Science Perspective" included in the syllabus of P.G. Diploma in Environmental studies offered by Dr. B.R. Ambedkar Open University. The topics included in this course cover the specialised social science aspects of environment. This syllabus for the sake of convenience is divided into blocks, each of which comprises a number of units. Each block generally covers a specific area of the subject. The units are written by the specialists in accordance with a format specially designed as to enable the student to read and understand the contents without much difficulty. Each unit begins with a statement of its contents followed by objectives. Each unit has at its end summary and model answers for the questions given under check your progress followed by model examination questions. Three assignments are given at the end of the book and the student is expected to submit at least one assignment to the Coordinator/ Asst. Director/ Deputy Director of the concerned study centre.

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This book deals with various aspects relating to Social Environmental Issues. The topics included in this book are global concerns of Environment, choice of technology, issues of survival, sustainable development, natural resources, human resources, technological imperatives, forestry, water resources, land use pattern, agriculture, urbanisation, industrialisation, energy, health, displacement, response of UNO and other international bodies, response of national, state and local governoments, green movement, legal response and role of impact assessment studies.

The university hopes that this material will help the student to get acquainted with environmental issues relating to social science. Critical suggestions for improving the text are most welcome and they will be incorporated in the future edition.

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BLOCK - 1
INTRODUCTION TO SOCIAL ENVIRONMENT

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UNIT-1 : GLOBAL CONCERNS OF ENVIRONMENT : A SOCIOLOGICAL APPROACH

Contents

1.1. Objectives
1.2. Introduction
1.3. Major Global Concerns
  1.3.1. Deforestation and Loss of Biological Wealth
  1.3.2. Bio-diversity, Biotechnology and Intellectual Property Rights
  1.3.3. Green House Effect and Climatic Change
  1.3.4. Ozone Depletion
1.4. Montreal Protocol
1.5. Population Growth and Poverty
1.6. Barriers to International Cooperation
1.7. Conclusion
1.8. Summary
1.9. Check Your Progress: Model Answers
1.10. Model Examination Questions

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1.1. OBJECTIVES

After going through this unit, you will be able to :

* explain the loss caused due to deforestation,
* define and explain green house effect,
* list out the reasons for the depletion of ozone layer,
* describe the Montreal Protocol,
* list out the barriers to International Cooperation.

1.2. INTRODUCTION

Though history of international environment cooperation is often traced from the Stockholm Conference on the Human Environment held in 1972, such cooperation has started much earlier. Transboundary agreements for the protection of migratory birds and the management of shared water resources date to well before World War I. The first serious, if unsuccessful, attempt at global environment management was probably Theodore Roosevelt's initiative in 1909 to convene at the Hague, a world conference for natural resource conservation. Standards to protect workers against occupational hazards by International Labor Organization (ILO), and Convention for Marine Pollution Control by International Maritime Organization (IMO) were few such earlier attempts.

However, it has to be agreed that the holistic outlook on environmental concerns and its awareness started growing concretely on global scale only after Stockholm Conference of 1972. This Conference was instrumental in initiating various legislations by national governments to control various types of pollution - viz., air, water and noise. Developments in the following decade showed that the progress on environmental concerns was far below the expectations of the Conference. Among other sweeping global changes that happened in the later half of the decade was a fundamental new application, importance of the environment to the human conditions and its very survival. They have become a major threat to the economic growth of any country and they are the determinants of nation's prosperity, security and governability.

Some of the reasons that can be attributed for apparent explosion of interest in environmental issues in later half of the 1980s, though they have been around since the early 1970's, include :

1. Global communication revolution brought home the devastating impact of environmental disasters like famines in Asian and African continents and environmental accidents like Bhopal gas tragedy, Chernobyl, and oil spills.

2 Governments used to be either influenced or pressurized by international environmental interest groups to take stock of the insights flowing from research on science of earth systems.

3. Lessening of nuclear threat during post cold war phase of the international sphere.

4. Technological advances made it possible to measure global phenomena on a vast scale, and both to handle and analyze the resulting mass of data.

5. Evidences of resultant ill effects of what we are doing have been accumulated from the top of the stratosphere to the ocean canyons.

6. Official views were also influenced by social and economic trends clearly linked to environmental conditions that seemed to augur ill for the future.

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If emergence of the environment on the global dimension can be indicated by a particular moment then it is the publication of the United Nations' report i.e., Report of the Commission on Environment and Development (Brundtland Commission as it was known), Our Common Future, in 1987. It has succeeded in looking at the linkages between diverse problems of the planet and was able to integrate poverty, hunger, debt, economic growth and still more problems into environmental issues. It enhanced the nature and quality of debate and had encouraged discussions on the environmental deliberations that took place at regional and international centres. The United Nations Conference on Environment & Development held at Rio de Janeiro in 1992 heralded the stabilization of environmental concerns among the high politics of international relations.

The structures established by and after the Stockholm Conference i.e., primarily under the aegis of the United Nations Environment Programme (UNEP) and global and regional institutions formed after UNEP had attempted to address various global environmental issues. The Commission on Sustainable Development, a product of Earth Summit of 1992, has also addressed these issues. The scope of these concerns for the environment has been leading to two main directions :

1. The scientific understanding of degradation of global environment and depletion of its limited resources through deforestation and loss of bio diversity, ozone layer depletion,

acid rains, global warming and climatic change, marine pollution, transboundary movement of hazardous substances etc..

2. That environment and development issues are closely interlinked is lately realized. Desirable levels of environment protection are dependent on economic and social development which in turn is meaningful if it is environmentally sound.

1.3. MAJOR GLOBAL CONCERNS

1.3.1. Deforestation and Loss of Biological Wealth

Considerable forest tracts in temperate regions of Europe, North Africa, North America and Asia long ago fell to the axe, but today, rampant deforestation is being carried out in tropical Asia, Africa and America. Tropical forests considered as living treasure houses contain uncounted habitats and species, diverse and individual, linked together in a complex web of interaction. These forest species are engines of biological productivity, sources of climatic stability and home for at least 500 million people. They contribute to human survival as sources of food, fiber, fuel wood, medicines, industrial products and the genes needed to breed improved crop varieties upon which the world's food security rests. In fact, only a tiny fraction of the potentially useful species of tropical forests has ever been identified.

Tropical forest loss reduces transpiration of water vapour into the atmosphere, changes reflectivity of the earth's surface (albedo), removes an important sink for ozone and through burning, contributes to the green house effect. Its essential services like watershed protection and regulation, the storage of carbon in plant tissues or the absorption and breaking of pollutants will be destroyed. They also lead to heavy soil erosion, frequent floods, droughts and desertification with decline in agricultural productivity and non-timber products.

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Food and Agriculture Organization report shows an estimated annual loss of some 11.3 million hectares of forest worldwide and researchers estimate that if the current deforestation trend continues then as many as 25% of all species inhabiting earth in the mid 1980's will be disappeared by 2015.

Root causes of the problem

1. Rapid population growth increases the pressure on the fewer resources available.

2. Flawed government policies for managing forests.

3. Neither the true value of the forest nor the cost of exploiting was accurately calculated resulting in faulty economic analysis.

4. Colonial patterns of resource exploitation that emphasize maximum short term gains.

5.. Debt load carried by many developing countries made it imperative to resort to timber exports.

6. High demand in developed nations for tropical timber and other commodities at the cost of exploiting forests to the maximum extent possible.

Contentious Dialogue

To curb further deforestation and loss of species many of the industrialized nations advocate regulatory regime at an international level and to have a global legal instrument on forestry. As against this, developing countries have been emphasizing their inalienable sovereign rights over their natural resources and call for compensatory financial aid by international community to offset the benefits foregone by tropical countries stalling the timber exploitation. They also argue that issues of bio-diversity should be discussed along with sharing of biotechnology as these are considered inseparable. Conciliation is needed in matters of such great concern among different interest groups of international community so as to curb increasing deforestation and bio-diversity loss.

1.3.2. Bio-diversity, Biotechnology and Intellectual Property Rights

As said earlier lot of biological wealth exists in the tropical regions of the Third World countries. The reason for sustenance of this bio-diversity is not entirely the result of a natural process but emerges through long historical practices and cultural habits of the people inhabiting the regions. The conservation activities carried out at the grass root level by communities led to preservation of existing bio-diversity. Advent of modern biotechnology led to emergence of a flood of opportunities for exploiting bio-diversity to commercial purposes. Today the value of drugs from plants found in tropical rainforests in the developing world alone is estimated to be US$43 billion or more in a year. Given the enormous potential of economic benefits of bio-diversity, Northern corporations and organizations have been altering or tinkering with the existing knowledge in the Third World and patenting these processes with the help of IPRs. Under the argument that plant varieties and breeds selected by farmers are the common heritage of humankind, these multinational corporations have been resorting to bio-piracy. They have been repatriating genes or germplasm from Third World countries and patenting them in their countries. Example of such piracy include the patents on products derived from the neem (Azadirachta Indica) by W.R Grace company of the United States.

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Contentious Issues

The developing countries claim right over genetic information conserved in Third World countries, as against the claims of the developed world, as a common heritage of mankind. The developing countries claim compensation for the exploitation of their genetic knowledge for already developed biotechnological innovations in the form of free transfer of technology. The developing countries do not accept the exclusive plant breeder rights being extended to seeds and pesticide companies by developed countries. As against this, they argue for farmer rights on account of the fact that farmers are breeders.

The entire debate on Trade Related Intellectual Property Rights (TRIPS) and farmer rights over biodiversity reveals clearly the reluctance of MNCs to pay dues to the countries that have conserved some of the most biologically diverse ecologically sites. But studies have shown that 705 of 119 pure chemical substances extracted from plants for international use in medicines were used for similar purposes by local communities. This clearly shows the evidence of usurping of the intellectual property of these people by multinational drug companies. Efforts are being made by conscious individuals from developed and developing countries to grant patenting rights to traditional knowledge system and practices so that the benefit reaches the communities which played predominant role in preserving the knowledge.

1.3.3. Green House Effect and Climatic Change

The green house effect is a natural phenomenon without which the earth would be too cold to support life. A part of the sun's energy is reflected from the earth's surface in the form of infra red radiation and the green house gases (GHGs) in the atmosphere such as carbon dioxide, chloro fluoro carbons (CFCs), Methane, Nitrous oxide, sulfur dioxide, etc., block this outward reflection partly and enable an increase in the temperature of earth's atmosphere. While at normal levels, their presence in the atmosphere is essential for maintaining life on earth and climate stability, their excessive concentration tends to make the earth more warmer. It is the enhanced greenhouse effect and its complications for climate change, which has become a major international concern.

Before the industrial revolution, carbon dioxide concentration was around 280 parts per million. But, today, it is about 360 ppm and is increasing at about 1.2 ppm per year. Along with carbon dioxide, other GHGs are being added to earth's atmosphere at accelerating rates and are now estimated to be about as significant in their collective impact on climate like carbon dioxide. Perhaps 80% of the carbon dioxide increase is due to burning of fossil fuels and the remaining is due to the burning of tropical forests and production of cement. It is estimated that by 2035 with continuing GHG accumulations at current rate will result in an increase in average temperature of 1.5 to 4.5 degrees centigrade for the earth as a whole. This may have a great impact on the humans and their environment.

Consequences of Climatic Change

1. Natural species which are unique to particular regions may simply die out or could be reduced on a massive scale and in some areas there can be increases in the population.

2. The possibility of dramatic changes in ocean currents would have catastrophic effects on fisheries and local climates.

3. Given their high levels of poverty, developing countries' adjustment to climate may be much more difficult or even impossible. Poverty implies less mobility and less flexibility to otherwise adapt to change.

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It was argued that limiting the consumption levels of fossil fuels with a determined effort at changing consumeristic lifestyles will go long way in limiting the dangers of climatic change. Western nations like United States are unwilling to take measures in this direction as proposed by Earth Summit. Developing nations like India argue that per capita GHG emissions in developed countries should be brought down on par with per capita levels of the developing countries. It is argued that if the burning of carbonaceous fuels is important then the problems arising out of severely reduced (clearing of) tropical forests, unnatural agricultural practices and production of CFCs and other halogen will also be important. This argument was contested by various agricultural scientists from developing countries and they contend that these arguments are attention-diverting tactics of the West. Combinations of voluntary restraints and international agreements can be the basis for real hope of drastically reducing GHG emissions on the global scale.

Check Your Progress - 1

What is meant by Green house effect?

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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1.3.4. Ozone Depletion

Ozone is a chemically active trace gas in the earth's atmosphere. Its chief characteristic property is that, if extraordinary thin layer of ozone molecules are dispersed throughout the atmosphere, particularly in the stratosphere, six to thirty miles in attitude, absorb certain wave lengths of ultraviolet radiation (UV-B) that can damage and cause mutations in animal and plant cells and thereby prevents them from reaching earth's surface. Through natural phenomena ozone is destroyed and created constantly but it is realized in 1970's that man-made gases like chloro fluoro carbons (CFCs) and halogens cause significant depletion of the ozone layer. These gases, which have wide applications in air conditioning, refrigeration aerosols, electronic and metal cleaning, foam blowing, modern fire-fighting, household products, pharmaceuticals, etc., since invention in 1920s are being used consumed in an increasingly rapid manner. These gases which deplete ozone layer resulting in enhanced levels of ultraviolet radiation that would then reach earth's surface could have potentially disastrous impacts on human health and environment. Researchers projected millions of future deaths from skin cancer, million cases of eye cataracts and blindness, suppression of human immune system, losses in food production and fisheries, damage to plastic and other materials and intensification of the greenhouse heat trap effect.

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Currently, global emissions of these gases are estimated to be 1.2 million Metric Tonnes per year. The United States and the European Community together account for over 60 percent of the global emissions. Over 11 percent by Japan, and another 11 percent by former USSR states. All the developing countries together contribute around 5% of the global emissions. It has to be noted that the emissions of the developing countries have started in recent years whereas the industrialized countries have been emitting these harmful gases for well over 50 years. New scientific finding by NASA, a United States aeronautical agency, established that stratospheric ozone over heavily populated regions of Northern hemisphere, including North America, Europe, Soviet Union, China and Japan had diminished by small but significant amounts.

Check Your Progress - 2 & 3

2. What are the gases responsible for ozone depletion?

3. What will happen if ozone is depleted?

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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1.4. MONTREAL PROTOCOL

Under the leadership of Mr. Mostafa Tolba, the United National Environmental Programme (UNEP) sought a global approach to ozone protection since 1977. After many rounds of negotiations at global and regional levels, in September 1987, the final round of negotiations adopted a Montreal Protocol on substances that deplete the ozone layer. The Protocol came into force by 1st January, 1989. This Protocol seeks to reduce CFCs consumption and production to 50% of 1986 levels, by 1998.

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Developing countries' concern : The protocol provided a ten-year grace period during which any developing country with per capita annual consumption below 0.3 kilogram would be permitted to rise to this level in order to meet its basic domestic needs. By 1989, many developing countries had second thoughts about the equity of the treaty arrangements. They argued that the average per capita consumption of developed countries was nearly 20 times greater than that of the developing nations. Their second concern was that low-cost supplies of alternatives to CFCs might not be available to developing countries during the transitional period in which they are allowed to expand their use of these substances, and on a continuous basis. Other additional costs might include new technology (patents and royalties), conversion of existing CFC facilities to new processes and prices of CFC substitutes, products, and associated capital equipment.

In June 1990, parties to the Montreal Protocol agreed to comprehensively amend the protocol to meet the concerns of developing countries like India. The protocol now guarantees financial cooperation to offset the adverse implications for the economies of the developing countries if they switch over to ozone friendly substitutes and undertake to facilitate the transfer of technology through a funding mechanism. Thus the Protocol could attract many of the developing countries into signing and making it as the most significant international environmental agreement in the history of global cooperation.

1.5. POPULATION GROWTH AND POVERTY

Rapid population growth is an alarming environmental concern of the global humanity. Though the problem is primarily that of developing countries of Africa and Asia, yet the developed countries cannot be immune to the spill over effects of such a problem. The immediate need of the hour is to break the circular chain of poverty - many children - poverty. All that is needed is for the poor countries is to develop and they might be spared the troubles arising from population growth.

Initially strongest case against population growth was offered by non-renewable resources but today it is the renewable resources whose shortages seem to sink us. After a threshold, above which further harvesting of renewable resource damages the resource itself. In a nutshell, it means that after a point in human population growth, the interaction between the natural system and the social system can become critical.

In 1950, the least developed countries (LDCs) had double the population of the more developed countries. At the present time they are over three times and by 2020 they are expected to be more than four and one-half times. Over and above these population figures, least developed countries are adopting development patterns of highly developed countries which are directed towards unwanted output of the economy. This leads to sudden expansion of formal education with greater demands for jobs, western lifestyles, increasing urbanization, above all, limited financial and technological resources available with the governments of these countries already burdened with sheer arithmetic of debt and adding to this the existing pressures on the fragile ecology of least developed countries showing signs of imminent catastrophe.

The developing countries attempt to focus the attention of the developed countries to the need for rising quality of life in these regions as a priority concern in any debate on global environmental concerns. To this requirement they plead for changing global orientation of trade, financial and technological policies to suit the needs of developing countries. Today's world population being around 6 billion, the evidence of damage to the biosphere will be greater still if another 2.5 billion is added along with continuance of present trends of production and consumption. There is nothing but disaster facing us. The need of the hour is to check the runaway population increase and substitute safer, cleaner and sustainable technologies for destructive ones.

Given these major global environmental concerns along with others let us briefly review some of the challenges that need to be faced in order to produce the necessary changes as well as the opportunities that exists in generating international cooperation in managing the transition to globally sustainable development.

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1.6. BARRIERS TO INTERNATIONAL COOPERATION

1. Differential impacts of global environmental problem on different states produces divergent responses at the negotiating table.

2. Unilateral initiatives to improve global environmental situation by nations may run the risk declining market share and employment.

3. Enforceability of international agreements becomes difficult if it infringes legitimate claims of significant sections of the society - for example, forest and tribal forest dwellers.

4. Many individuals and institutions have larger stake in maintaining the status quo.

Opportunities

1. Inefficiency of many current activities is a common ground for achieving environmental improvement through co-operative effort.

2. A creative use of policy instruments could institutionalize and regularize a system of sharing the costs of meeting global pollution control goals.

3. Assuring that the stringent environmental policies are cost effective.

4. Conventional or traditional use and management practices need to be incorporated into policy instruments so that incentives to local and global communities in sustainable management can become compatible.

5. Eliminating the current distortions in international trade patterns and rationalizing trade policies to achieve sustainable life styles, evolving debt reduction strategies for meeting least developed countries' requirements, emphasizing on internationally environment-friendly judicial policies and practices, incorporating emission taxes as done in case of CFCs, changing accounting practices to include natural resource inventories, etc.. could create tremendous opportunities for achieving the long term goal of sustainable global development.

1.7. CONCLUSION

In this chapter we have focussed on how environmental concerns have gradually occupied prime position in international diplomacy and politics - the factors, the interests and the lobbies that contributed towards this direction. Secondly, we have various major global environmental concerns and the current and future impacts on humankind. Here the various contentious issues in each of these concerns were attempted to be presented in brief so that student roughly gets an idea about issues involved. Given the complexity of the subject matter, justifying all the concerns in lucid manner in a lesson is beyond possibility. The international debate about North-South relations on environmental concerns is sought to be presented.

Finally, it was attempted to show that through the acceptance of the motion of a single earth spaceship, nations should rise above narrow nationalistic outlook in order to find lasting solutions to the major environmental concerns that are threatening the very survival on this earth leave alone all the flora and fauna. It should be noted here that non-governmental organizations operating on environmental issues at international level like Green Peace, Sierra Club, etc.. have been focussing the attentions of humanity towards environmental concerns in order to make our life styles more sustainable and long lasting.

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In this context, it is often said in the international circles that one should learn to imbibe the notions of 'Thinking Globally and Acting Locally' to address various global as well as regional ecological concerns. Hence the responsibility in this regard should be shouldered by international institutions like United Nations, World Bank, WTO, FAO, etc., at the international sphere in consultation with the comity of nations and community of NGOs. Similarly, at the national and regional levels respective governments and non governmental institutions should initiate affirmative actions. The responsibility also lies on communities and individuals for making concerted efforts to reduce the threats to global environment.

1.8. SUMMARY

The global environmental cooperation was started with the Stockholm Conference on the human environment in 1972. After this conference a holistic outlook started growing concretely on environmental concerns and its awareness.

Considerable forest tracts in Temperate regions of Europe, North Africa, North America and Asia fell to the axe and rampant deforestation is being carried out in tropical Asia, Africa and America.

The forests contribute to human survival as sources of food, fiber, fuel wood, medicines etc. Forest loss reduces transpiration of water vapour into the atmosphere, changes reflectivity of the earth's surface (albedo) and contribute to the green house effect. This also leads to soil erosion, frequent floods, droughts & desertification with decline in agricultural productivity.

The greenhouse effect is a natural phenomenon without which the earth would be too cold to support life. a part of Sun's energy is reflected from the Earth's surface in the form of infra red radiation and the greenhouse gases in the atmosphere such as carbondioxide, chlorofluorocarbons, methane, nitrous oxide, sulphur dioxide etc block this outward reflection partly and increases the temperature of earth's atmosphere. At normal levels, the greenhouse gases are essential for maintaining life and at higher levels changes the climate drastically.

Ozone which is present in stratosphere absorbs ultraviolet radiation which causes mutations in human beings. Man made gases like chloroflurocarbons and halogens cause depletion of ozone. The depletion of ozone results in enhanced levels of ultraviolet radiation on the earths surface and it causes disastrous effects on human health and environment.

Under the leadership of Mr. Mostafa Tolba, the United Nations Environmental Programme sought a global approach to ozone protection. In September 1987, Montreal Protocol was adopted on substances that deplete the ozone layer. The protocol seeks to reduce the CFC's consumption.

1.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Certain gases such as carbondioxide, chlorofluoro carbons, methane, nitrous oxide, sulphur dioxide, etc., absorb the infrared radiation and increase the temperature of the earth's atmosphere. This is called Greenhouse effect.

2. Man made gases like chlorofluoro carbons and halogens are responsible for ozone depletion in the stratosphere.

3. Ozone depletion leads to enhanced levels of ultraviolet radiation on the earth's surface which will have disastrous effects on human health and environment.

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1.10. MODEL EXAMINATION QUESTIONS

I. Answer the following question in about 30 lines each.

1. Write briefly about major global concerns.
2. Write an account on Montreal Protocol.
3. Briefly write about population growth and poverty.

II. Answer the following questions in about 10 lines each.

1. Write briefly about greenhouse effect.
2. Briefly write about ozone depletion.

Mr. K. Thilotham Reddy

UNIT-2 : CHOICE OF TECHNOLOGY

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2.4. Impact of Modern Technology on Developing Countries
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2.6. Appropriate Technology
2.7. Conclusion
2.8. Summary
2.9. Check Your Progress : Model Answers
2.10. Model Examination Questions

2.1. OBJECTIVES

After going through this unit, your will be able to :

* describe the role of technology in the human history.
* describe the impact of modern technology in various countries,
* explain the appropriate technology for developing nations and constraints involved in it.

BRAOU

2.2. INTRODUCTION

Often technology is identified with the hardware production - knowledge about machines and processes. But a broader definition of technology extends to all the skills, knowledge and procedures for making, using and doing useful things. It encompasses the nature and specifications of what is produced - the product design - as well as how it is produced. It also includes marketing techniques and administration, education, banking services, etc. The wider definition is of importance since there are relationships between the hardware and the software. Between, for example, mechanical process, managerial techniques and infrastructure services which help determine the choice made in both spheres. Technology available to a particular country is all those techniques it knows about and could require, while the technology in use is that subset of techniques it has acquired. Today technology is a major determinant of most human activities, expectations and even belief systems. It has virtually unlimited potential for good; it could bring disaster if wrongly used, to all the organisms and material make up of this earth.

2.3. HISTORICAL OUTLOOK

In determining the nature of human and environment interaction, technology played a vital role. In the history humankind from early tool technology to the present days space technology, technology has been continuously transforming human lives, lifestyles, culture and their living environments.

Technological change is a response to the increasing accessibility to resources of the region and the needs and requirements of the people inhabiting the region. The record of man-nature interaction shows that in the early phase human beings were evolving technology to survive under the harsh and all pervading forces of nature. In the ancient and medieval periods of human history though technological progress has been recorded but the equation of man-nature interaction was more or less based on co-existence i.e., in todays parlance, sustainable. These societies viewed physical as well as biological components of the nature and the human population as being linked together in a web of relationships. This holistic world view can be characterized as an 'I-thou' relationship between humans and nature.

As Judeo-Christianity started taking roots against the pagan faiths of medieval Europe, 'I-thou' relationship between humans and nature gradually started transforming into 'I-it' relationship. The emergence of renaissance, reformation, geographical discoveries and early scientific developments in Europe have resulted is drastic changes in socio-economic, religio-cultural and philosophical spheres of European societies. Emerging value systems regarding man-nature relationship in the contemporary period is best illustrated in the words of Francis Bacon (1561-1626) acknowledged as the father of modern science and technology. According to him, nature has to be hounded in her wanderings, bound into service, and made a slave... put in constraint and molded by mechanical arts. The aim of the scientist is to torture nature's secrets from her. Rene Descartes, the first modern philosopher and a persuasive advocate of scientific reduction in seventeenth century also echoed notions similar to Bacon. According to him, science and technological knowledge should enable mankind to appropriate uses from nature and command over nature.

Thus scientific and technological revolution functioned as cultural sanctions for denudation of nature. This transformation of nature from a living nurturing mother to inert, dead and manipulating matter was eminently suited to the imperatives of growing capitalism in Europe. Another important feature of this revolution was its reductionist orientation whereby all other knowledge systems (traditional knowledge systems of both western and non-western) whose outlook of nature as diversified living organism were either subjugated or replaced. With the embrace of Darwinism in nineteenth century and the transformation of Western science and technology into a domineeringly homogenized reductionist paradigm went hand in hand with rapid industrialization, the rise of market capitalism and the expansion of colonialism.

EPGPOU

As Winin Periera puts it: "It was a pure myth that industrial revolution was pure technological ingenuity. Without occupied territories, the industrial revolution could not have occurred, proceeded and fructified as it did. Indeed the ghosts of slavery, colonization, exploitation and the subordination of humanity to production continue to haunt the Western economic system and they reappear in modified guises, in all European prescriptions to the two thirds World for prosperity and wealth. Darwin's theory of survival of the fittest though served the purpose of explaining the organic evolution was sought to be implanted in social theorizing for serving as a rationalization of colonialism and domination of western outlook over that of the non-Western outlook. Similarly the homogenizing tendencies of western technological onslaught on the traditional technologies when combined with the power and profit motives of capitalist economic enterprise has altered the scenario in non-Western regions to irredeemable proportions.

Given the motivation of power and profit involved in the spread of Western technology, it is projected as having qualitative attributes of objectivism, neutrality and progress. It has gained such an acceptance even in the non-Western regions that it is considered today as a superior and universal technology with value neutrality regarding gender, class, country, etc.. This notion is being increasingly getting proved to be false and it is beginning to be understood that the genesis and

growth of modern technology in the Western world had the needs, interests, compulsions and constraints of its economic development and the profit and power motives of its elite (upper social sections). Thus, barring a few notable exceptions, technological developments over the past 150 years have been centered in the industrially advanced (Western) countries. This means that in addition to the remaining traditional techniques, the Third World countries have little choice but to use techniques developed in advanced countries and the most part produced there too.

Consequently, the available technological choice is largely circumscribed by technological developments in the Western countries. More over the technological choice is mainly confined to the techniques currently produced in the advanced countries because older techniques of the advanced countries become obsolete due to their inefficiency, for both less developed as well as advanced countries.

2.4. IMPACT OF MODERN TECHNOLOGY ON DEVELOPING COUNTRIES

During the colonial phase, introduction of modern technology essentially to serve the needs of colonial masters led to large scale depletion of natural resources and unbridled exploitation of human resources of the Colonies. Traditional industries and knowledge systems were systematically subjugated or replaced by the so called modern technology using instruments of state powers. Traditional industries which flourished up to 18th century, producing a variety of consumer goods, declined under impoverished conditions imposed by colonialism. This led to the situation wherein commodity trade of traditional industries declined both in domestic and Western markets. Thus commodity surplus trade of colonies was replaced by the exchange of raw materials for finished goods of the European industries. The nature and magnitude of production under industrial revolution began shifting and expanding from small and batch production in households to large mass production in factories. Consequently, in the Indian context, of about 15,000 and odd traditional technologies, processes and practices existing then, what survived this great onslaught were only a few hundreds or about 2400 traditional technologies when India became independent.

BRAOU

After decolonization, the independent nation-states in Afro-Asian continents adopted developmental paradigms of the Western nations. They started borrowing Western technologies in order to catch up with the advanced industrialized nations. Thus technologies developed to suit the requirements of western nations were sought to be implanted in these nations. Given the high levels of poverty, unemployment, and population growth combined with limited capital base and significant socio-economic, cultural and ecological differences with the advanced nations, these technologies have created lopsided development. This only increased the gap in the income levels in these developing countries. It led to a creation of dichotomy between India (i.e notion of a nation of urbanized educated and high income level elite) and Bharat (i.e a notion of a nation of the rural, impoverished, uneducated and poor masses). With each passing decade the pool of unemployed people is increasing at an accelerated pace. The pressures of migration and large scale urbanization are increasingly becoming strenuous putting heavy pressures on limited public resources.

2.4.1. Inputs of Technology in Agriculture

In the agriculture sector, technological inputs in the form of green revolution was able to solve food security problems of Third World countries. But, these inputs, acclaimed as advance world's response to the Third World's food crisis, simultaneously generated innumerable long term economic and ecological ill effects. This led to greater agricultural inputs in the form of inorganic and chemical

fertilizers and pesticides along with emphasis on labor saving heavy machinery utilization. This led to the scenario of increasing the capital input requirements and thus making farming by the small and marginal farmers economically unviable.It's labor saving strategies gave scope for increasing the rural unemployment. It involved the disruptions of the essential links between forestry, animal husbandry and agriculture which have been the basis of sustainable agricultural practices. Green revolution has not only displaced seed varieties but entire crops of the Third World by propagating mono culture and uniform cropping patterns. It also lead to increased soil and nutrient loss, water-logging, salinisation, and increasing usage of inorganic fertilizers and pesticides thereby poisoning the web of life.

2.4.2. Industrial Technology

In the industrial sector, given the bias towards modern capital intensive technology, the process of modernization of industrial units and upgradation of technological base of the country in the name of enhancing efficiency and productivity is resulting in retrenchment of labor. Modern technology is sought to be made efficient by cutting on 'expensive' labor costs, a normal practice in advanced countries because of high costs of manual labor. Such labor-saving, high-intensive technologies are fundamentally unhealthy for the economies of the developing countries. The bias towards modern technologies is also because the determinants of choice (decision makers and institutions) tend to be biased towards them. Its selection mechanisms appear to justify this technological choice making it appear privately and often socially profitable. This leads to little incentive to search for alternative technology.

Secondly, those dissatisfied with the consequences of the technological choice concentrate on changing the selection mechanisms rather than searching for alternative technology. But the selection mechanisms themselves are part of technological package, hence not independent of the technological choice. Thus, the inappropriate nature of advanced technology for underdeveloped countries arises from differences in the economic and institutional environment between the advanced and Third World countries.

BRAOU

There are also obvious climatic differences, different availability and costs of raw materials. For example, modern energy production technologies are focussed on conditions in advanced countries. Hence, during the colonial period, when coal was abundantly available it was used to generate energy for industrial as well as transport purposes. Similarly, when global oil crisis of 1973 badly hit the advanced countries due to their over dependence on Gulf oil resources, only then energy efficient technologies have been evolved. Today, concentration is on nuclear energy rather than on sources of energy like sun and wind which are abundantly available in the Third World countries.

India is no exception to this practice, as it is reflected in it's energy planning and policies. If we look at the National Budgetary allocations in the past two decades, the resources allocated to the Ministry of Non Conventional Energy Sources is around less than one percent. This shows the importance given by our planners to the highly potential sources of energy in meeting our energy needs which are acclaimed as environment friendly.

2.5. TECHNOLOGY AND SOCIAL INEQUITABILITY

Apart from the physical differences, the major forces that make modern technology inappropriate for Third World countries include factors like organization of production, economic factors, particularly income levels and technical factors. The huge gulf, between the organizational form to

which advanced technologies are designed and suited. and forms of organization indigenous to most Third World economies, has meant that the use of advanced technology also generally requires the use of advanced countries' techniques of management and organization. Thus, ruling out the possibility of local development of local entrepreneurial talent because the jump between current experience and what is needed is far too great, since the income levels are of great significance in achieving technological development from the point of view of both demand and supply.

In addition, resource availability in terms of savings per capita and educational resources per capita are closely related to income per capita. Given the differences in income levels, transferring technology leads to distorting effects on the economy. Thus, while the transfer of inappropriate products require large scale inequality of income distributions in developing countries for creating adequate markets, the transfer of technology also contributes to the required inequalities.

Finally, coming to technical factors, it should be noted that as technology advances, the linkages between various techniques becomes completely interwoven whereby reducing the room for variation in techniques from making them appropriate to developing countries. These links extend to requirements of particular type and level of transport, of legal and administrative services, product inputs and so on. Given such difficulties, any reproduction of technology is imperfect. As such the criticisms like lack of productivity, inefficiency, corruption, etc. leveled against developing countries are also due to this.

Indian Scenario

In post independent India, major thrust was given to modern science and technological development to serve the purpose of alleviating poverty, reducing inequalities, increasing employment opportunities and enabling society to become truly self-sustained and sovereign. But inspite of fifty years of efforts in the past, approximately 75 percent of the country's population does not have an access road during monsoons. Equal number of villages neither have post office nor telephone facilities.

BRAOU

Even in the advanced nations, modern technologies are increasingly proving unsustainable and economically inadequate to serve as a framework for culturally enriching growth, detrimental to ecological balances and counter-acting on the fundamental human values of freedom, non-violence and justice. With increasing realization of limitations of modern technology, there is a search for alternate technological paradigm which serves the needs of larger sections of society and also creates sustainable economic practices and lifestyles. The effort in this direction is two dimensional. On one side, there is an effort to reuse the left-over traditional technologies and knowledge systems especially of the Third World countries and on the other side, there is an effort to create an appropriate technology that suits the needs and requirements of the regions and the people inhabiting them.

Gandhi's appeal for simple rural based technology for serving the communitarian needs of village in the Indian context is proving to be prophetic in its predictions about impact of modern technology. In fact, Gandhi has warned that direct introduction of modern technology is going to be a curse for mankind.

The dehumanizing role of that modern technology even in advanced countries was brought out clearly by Gandhi. Accordingly, he said that modern technology makes an individual atomized and enslaves the person to machines, thereby generating anomic tendencies in place of harmonic and spiritual constitution of the personality. His in-depth understanding of the Indian milieu led Gandhi to advocate for orientation of industrial policy and practices towards the labor intensive village

based small and tiny industries. This, he believed, would help in retention of communitarian work ethics thereby developing a sense of participation and belonging. His spinning wheel (CHARKA) symbolizes his technological value orientations and commitment.

But, for the advocates of modern technology, this thinking represents a traditional, medievalistic approach towards technological progress. However, Gandhian economists like J.C. Kumarappa have persisted with their insistence on traditional knowledge systems and technologies for achieving 'economy of permanence'. With the growth of ecological outlook the world over, these views have gained increasing acceptance and there is a sort of rediscovery of Gandhian ideology regarding technological choice by the world at large. Various efforts have been made to revive, support and revitalize traditional knowledge systems. In India, one such effort in this direction is the organization of the Congresses on Traditional Sciences and Technologies in India. Though this is a small step, but a step in the right direction in recognizing, retrieving and reestablishing the long neglected traditional technologies and processes.

Check Your Progress - 1

Major thrust was given to modern science and technological development in independent India. Why?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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2.6. APPROPRIATE TECHNOLOGY

Efforts to create alternate technologies that are appropriate to the demands of the less developed countries started with the publication of the 'Small is Beautiful' by E.F. Schumacher in 1973, which generated a movement for creation, adaptation and networking of Appropriate Technologies. Numerous scientists, technologists, and economists have reoriented their priorities by responding to the calling for the need for alternate technology. In order to promote appropriate technology (what was earlier referred as intermediate technology by Schumacher), in 1965, along with George McRobie and Mrs. Julia Porteo, Dr. Schumacher set up the Intermediate Technology Development Group Ltd., (IDG). Following this initiative, several technological centres have been set up in developing countries. These advocates for appropriate technologies have grown in number over years. In India, Mr.A.K.N.Reddy of Indian Institute of Sciences, Bangalore, has done remarkable contribution in the area of developing appropriate technologies for the energy needs of rural India. The major criteria that respond to the majority of the concerns of a holistic and humanistic technological choice can be delineated as following :

1. Technology should be locale specific. This means that different technologies have to be evolved for serving divergent ecological regions.

2. Technology should be simple without a need for greater skills among the humans who man these machinery. It means to saying that the emphasis should be on simplicity in operation, organization and repair so that a highly specialized and skilled human resources are not mandatory.

3. Technology should be cheap and small scale such that local entrepreneur should be able to generate resources within the community.

4. Technology should generate goods mostly for the local markets but export possibilities need not be shunned.

5. Technology should be labor intensive so as to address to the employment requirements of the rural as well as the urban regions of the developing world.

6. Technology should utilize local raw materials so as to reduce the dependency on other regions and also reduce the transportation costs.

7. Technology should be energy saving with emphasis on using renewable energy sources.

8. Technology should provide scope for local creativity and local entrepreneurship. This would lead to the possibility of technological upgradation and innovation by using the local genius.

9. Technological application should result in sustainable economic practices as well as sustainable life styles.

10. Technology should reduce the drudgery and sufferings of the manual laborers, artisans and womenfolk of the villages.

11. Technology should be compatible with the local cultural mores and practices.

12. Technology should satisfy the locals wishes and needs, more so to address the requirements of food, water, clothing, shelter, health, education, etc.

BRAOU

Constraints to Appropriate Technology

1. Not only resources are being used for the development of techniques in and for advanced countries, but even the research and development carried out in Third World countries is mainly devoted to the sort of techniques that are in use in the modern sector in those countries.

2. Despite the existence of more appropriate alternatives, inappropriate techniques continue to be used in developing countries because the economic and social structures favor the choice of inappropriate technology.

3. Appropriate technological existence is closely linked with the whole strategy of development that is adopted in the country. In an environment where rapid industrialization with advanced technology is being emphasized, alternative technology cannot survive, or would be readily developed.

4. Given the linkages between social, economic, political and technological system, in general usage of advanced techniques creates bias against selection of alternate techniques. In effect, the socio-economy of a system determines the choice of technology.

5. Ultimately, the answer is to be found in the realm of politics rather than economics and technology. But the close connection between these three suggest that there are economic and technical preconditions of a successful move, necessary of appropriate technologies, even if there are not sufficient conditions.

2.7. CONCLUSION

Understanding of the meaning of technology needs to be broadened to include all the skills, knowledge and procedures for making, using and doing useful things. With such an understanding if one looks at the history of technological development it can be concluded that, firstly, the rate of technological progress has accelerated by leaps and bounds in the modern age i.e., after 15th century in general and after industrial revolution of 1870s in particular. Secondly, technology is conditioned by the social, economic, ecological and political factors of the countries in which they originate and profit and power motives are very much evident in its progress. Thirdly, in the process of advancement, modern technologies have either subjugated or replaced the existing traditional technological knowledge systems which do not confirm to its criteria. Fourthly, the ideological support base generated by modern technology led to its adaptation even in the developing countries inspite of their inappropriateness to their socio-economic conditions. Fifthly, the signs of ill effects of modern technologies is visible not only in Third World countries but also in the so-called advanced countries, in the form of environmental, ecological, social and cultural degradation.

There is scope for alternate technology which is appropriate for developing countries, as advocated by the stalwarts like Mr.M.K.Gandhi, J.C. Kumarappa, E.F. Schumacher, etc.. However, in the present situations, certain criteria need to be employed in choosing appropriate technology, in lieu of the different influential factors that might impede the growth of appropriate technology.

BRAOU

2.8. SUMMARY

Technology is usually identified with the production of hardware. But technology extends to all the skills, knowledge and procedures for making, using and doing useful things. Technology played a vital role in determining the nature of human and environment interaction.

During the colonial phase introduction of technology essential to serve the needs of Colonial Masters led to large scale depletion of natural resources and exploitation of human resources of the colonies. After decolonisation, the independent nation states in Afro-Asian Continents adopted development paradigms of the western nations. They started borrowing western technologies.

In the agriculture sector, technological inputs in the form of green revolution was able to solve food security problems of Third World countries. In the industrial sector, the process of modernisation of industrial units and upgradation of technological base of the country in the name of enhancing efficiency and productivity resulted in the retrenchment of labour.

In the post independence India, major thrust was given to modern science and technological development to serve the purpose of alleviating poverty, reducing inequalities, increasing employment opportunities and enabling society to become truly self sustained and sovereign. Gandhiji's appeal for simple rural based technology for serving the communication needs of village in the Indian context is proving to be prophetic in its predictions about the impact of modern technology.

2.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. In post independence India major thrust was given to modern science and technological development to serve the purpose of alleviating poverty, reducing inequalities, increasing employment opportunities and enabling society to become truly self-sustained and sovereign.

2.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Write briefly about the role of technology in the human history.
2. Write an account on the impact of modern technology on developing countries.
3. Briefly write about technology and social inequality.

II. Answer the following questions in about 10 lines each.

1. Write briefly about technology in agriculture.
2. Write briefly about industrial technology.
3. Briefly write on need of appropriate technologies to less developed countries.

BRAOU

Mr. K. Thilotham Reddy

UNIT-3 : ISSUES OF SURVIVAL

Contents

3.1. Objectives

3.2. Introduction

3.3. Loss of Biodiversity

3.4. Conclusion

3.5. Summary

3.6. Check Your Progress : Model Answers

3.7. Model Examination Questions

3.1. OBJECTIVES

After going through this unit, you will be able to :

* define and describe the word survival,
* describe and discuss about biodiversity,
* describe genepiracy, and
* describe patenting of seeds.

BRAOU

3.2. INTRODUCTION

The word survival till recently had clear economic tones. It has been linked with a profession or an occupation with a fixed income. It is also obviously related to price index, increase in emoluments or crop failure, late monsoon pests and drought. At the level and context where it is discussed it is ofcourse not irrelevant. Erratic price index and monsoon or drought and crop failure do make our survival difficult.

But today a small but vocal section of thinkers and others have been trying to add a new dimension to the basic issues of survival. Not only that, the scope of the discussion has been widened to include the whole world, since issues of survival could not be localised any more. Issues affecting a part of the world have a direct or indirect influence on other part of the world. This view also helped to look at the world as global village inhabited by mankind not withstanding its great diversity. This attitudinal change has been brought about by ecologist who argued that basic to the survival of mankind as a whole was our ability to keep the ecological balance or in more practical terms to keep a judicious balance between consumption and conservation of our resources. It is now generally realised that the real issue of survival is the conservation of our fast depleting resource base. Political systems had to grudgingly accept that the populist development strategies might be counter productive. The Third World or the South has been particularly vulnerable to over exploitation of resources.

Hence this century's last decades shocked the world into accepting sustainability as the only means of our survival. It is now clear that the volume of exploitation of resources is dangerously out of proportion to their regeneration.

But how exactly has the process of regeneration of our resource base been on? Resources of the world or all these eco-systems supported human life in their own distinctive way for centuries. In simplest of terms bio-diversity is that diverse arrangement of resources like water, forests, land etc. So human intervention however well intentioned is bound to disturb the diversity, often overlooking the fact that the natural order of things ensures survival. It was this bio-diversity that nurtured diverse ways of life which evolved as unique cultural patterns. Hence ethos of all these cultures contain a conservation ethic in the form of mythology, folklore, belief - systems, conventions etc. Unless we are able to understand the damage or erosion being caused to the genetic pool we would not be in a position to comprehend the long-term consequences.

3.3. LOSS OF BIO-DIVERSITY

Erosion of bio-diversity is erosion of our resource-base. Actually forest facilitated human survival. Various items of food, medicines, domestic animals, building material etc. come from forests. Rice varieties, pulses, leaf-vegetables etc are genetic variations of wild species. Virtually millions of species of medicinal plants and herbs await discovery and study. They might lead to relief from diseases that have been defying cure. Development projects, mining and logging have been causing large-scale deforestation. It is difficult to put value on bio-diversity in terms of rupees. The value is beyond monetary standards.

Wildlife is ofcourse part of the forest eco-system. Depletion of one leads to the extinction of the other. Wildlife helps natural regeneration of forests. Already wild animals like tiger, lion and even elephant have joined the list of endangered species. There are many bird and other animal species that are already extinct. We must bear in mind that future of human survival is inextricably linked to the preservation and regeneration of forests. Minor forest produce like honey, bark, gums, fruits and countless other items have been part of our life.

BRAOU

What is crucial to our present and future is efficient management of bio-diversity. World scenario in this regard has been causing concern. Famed Amazon forests, African forests and Indian tropical forests show alarming rate of depletion and degradations.

- In our country one crore trees are felled annually.
- This leads to depletion of 1.5 million hectares of forests.
- The depletion leads to top-soil erosion to the tune of 6 billion tonnes annually.
- About 3000 plant species in our country are reported to be on the way to extinction.

It is in order to save the bio-diversity world all over, a bio-diversity convention was held in 1992. India was a party to the convention. Except the U.S.A. all other nations signed the document.

It is not generally realised that indigenous cultures are intimately related to bio-diversity. These forest dwellers live in harmony with nature, living on the minor produce of the forests without endangering it. But they have intimate knowledge of the flora and fauna and especially of the medicinal herbs, plants etc. But these colourful cultures have been steadily disappearing primarily consequent owing to reckless deforestation. Huge irrigation dams and deforestation has been displacing the forest dwellers without realising that these people carry unique knowledge and a work-view that is of great relevance to our traumatised contemporary life.

Check Your Progress - 1

How many trees are cut annually and how many are on the way to extinction in our country.

Note : (a) Write the answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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It is also useful to understand the linkage between vanishing species and vanishing cultures.

A disturbing development in recent decades adds serious warning to an aspect of bio-diversity. When compared to the developed nations, developing nations are endowed with rich natural resources. These resources are exploited by the developed nations by various means. It may not be widely known but even our genetic resources are subtly pirated from our country. Claude Alveres, well-known Goan ecologist called it "genepiracy". Healthy animal genetic material thus goes out of the country. It is for example feared in some quarters that the famed Ongole bull was an endangered specie. Genes of this bull were crossed with local species in some countries. It is not as though such experiments are unusual. But in recent times owing to certain development each nation has to protect its own genetic pool from erosion. Otherwise the consequences could be frightening in future. In a vast country like ours different species of birds, animals and sub-species exist (for example Indian sub-continents' bull, '<u>Bacus indicus</u>' is sturdiest and the most ancient species). Degeneration or near-extinction of species will have harmful effects on our resource base. If unchecked, this will have chain-reaction, ultimately effecting the vitality of the nation. At one time Asian countries among themselves had an astonishing 2,00,000 varieties of rice which are now absent. In our own State hundreds of such species are known till recently. Owing to mono-culture of hybrid rice-strain the indigenous species have vanished leading to large scale soil degradation.

BRAOU

Intimately connected with genetic-pool erosion is patenting of seed which came into vogue recently. In simple terms patenting of any seed is rendered easy by any technically advanced country. Inspite of international agreements (which have been alleged to be based to the developed North) very recently an American concern tried this by patenting the neem seed in a notorious exercise. No possibility could be discounted in future. It was on the ground that the North has been given unfair advantage that the Dunkel Draft came under wide criticism. Patenting of seeds comes under Intellectual property rights of the Draft. Unless a product is registered under the above any outsider can claim patents. Thus technically a farmer has no right on the seeds. After a hue and cry Indian Govt. denied that agro-products could be patented under Dunkel Draft. It may be too early to say anything final in this matter. But what is certain is that our genetic resources are not as safe as they appear to be.

3.4. CONCLUSION

Bio-diversity holds the key to the survival of mankind. Loss of this natures' most intricate eco-system results in the erosion of our resource-base. We must do everything possible to strike a balance between consumption and regeneration.

Indigenous people have been protecting our forests. Their way of life and world view have a message for the modern man. Also when these cultures vanish Bio-diversity also would vanish. Rare plant and animal species have becoming extinct. Future medical and food needs could be in jeopardy owing to this.

Genetic pool needs conservation today. Genepiracy could lend a country into future dependence and degeneration. Nation's wealth could be at stake. Already countless number of rice-varieties have vanished yielding place to hybrid seeds. Result has been steady land degradation in several places. Mono-culture has come to stay.

Recent criticism of Dunkel Draft regarding patenting of seeds as part of intellectual property rights seems to be justified at least technically. If checks are removed even ordinary peasants will lose rights over seeds they produce. We have to appreciate the linkages in nature.

3.5. SUMMARY

The word survival had always related to economy. It is also related to price index, increase in emoluments or crop failure, late monsoon, pests and drought. The real issue of survival is the conservation of our fast depleting resource base. The resources of the world or a region are not equally distributed. But all the ecosystems have been supporting human life for centuries.

Bio-diversity has been eroding. Actually forests facilitated human survival. Various items of food, medicines, domestic animals, building material etc come from forests. Millions of species of medicinal plants which can relieve from diseases await discovery and study. Wildlife is also part of ecosystem. Depletion of one leads to the extinction of the other. Tiger, lion and elephant have joined the list of endangered species. Many birds and animals are already extinct. Everybody should bear in mind that future of survival is always linked to the preservation and regeneration of forests.

BRAOU

In our country one crore trees are cut annually. It leads to soil erosion. About 3000 plant species in our country are reported to be on the way to extinction. The developing countries are endowed with rich natural resources than the developed nations and the developing countries are exploited by the developed nations.

Recently patenting of seed has come into practice. Unless a product is registered any outsider can claim patent. Technically a farmer has no right over the seeds.

3.6. CHECK YOUR PROGRESS : MODEL ANSWERS

1. In our country one crore trees are cut annually and 3000 plant species are reported to be on the way to extinction.

3.7. MODEL EXAMINATION QUESTION

I. Answer the following questions in about 30 lines each.

1. Write briefly about various issues of survival.
2. Write an account on the loss of Bio-diversity.

II. Answer the following questions in about 10 lines each.

1. Write about patenting of seeds.
2. What are the different products which are obtained from the forests.

Dr. T.P. Sastry

UNIT-4 : SUSTAINABLE DEVELOPMENT

Contents

4.1. Objectives
4.2. Introduction
4.3. Concept of Sustainable Development
4.4. Equality And Common Interest
4.5. Strategic Imperative
4.6. Conclusion
4.7. Summary
4.8. Check Your Progress : Model Answers
4.9. Model Examination Questions

4.1. OBJECTIVES

After going through this unit, you will be able to :

* explain the concept of sustainable development,
* explain the ways of preservation of renewable and non-renewable natural resources,
* describe the ecological interactions,
* describe the traditional social systems and enforcement of common interest.

BRAOU

4.2. INTRODUCTION

Development involves a progressive transformation of economy and society. A development path is sustainable in a physical sense. Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts.

* The concept of needs in particular the essential needs of the world's poor should be given overriding priority.
* The idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs.

Thus the goals of economic and social development must be defined in terms of sustainability in all countries - developed or developing, market oriented or centrally planned. Interpretations will vary, but must share certain general features and must flow from a consensus on the basic concept of sustainable development/and on a broad strategic frame work for achieving it.

4.3. CONCEPT OF SUSTAINABLE DEVELOPMENT

Development involves a progressive transformation of economy and society. A development path that is sustainable in a physical sense could theoretically be pursued even in a rigid social and

political setting. But physical sustainability cannot be secured unless development policies pay attention to such considerations and benefits. Even the narrow notion of physical sustainability implies a concern for social equality between generations, a concern that must logically be extended to equality within each generation.

Sustainable Development and Quality of life : Poverty and inequality are endemic and will always be prone to ecological and other crisis in the developing countries. The essential needs of vast numbers of people for food, clothing, shelter and jobs are not being met and beyond their basic needs, these people have legitimate aspirations for an improved quality of life. To meet the basic needs of all and to extend to all the opportunity to satisfy their aspirations for a better life a development path should be sustainable.

Promotion of Values and Sustainable Development : Sustainable development requires the promotion of values that encourage consumption standards that are within the bounds of the ecological possible and to which all can reasonably aspire. Sustainable development clearly requires economic growth in developing countries where the meeting of essential needs are not being met. Growth by itself is not enough because of high levels of productive activity and widespread poverty can co-exist and can endanger the environment. So the content of growth should reflect the broad principle of sustainability and non-exploitation of others. Hence sustainable development requires that societies should meet human need both by increasing productive potential and by ensuring opportunities for all.

Sustainable development can only be pursued if the proper distribution of resources and demographic development are in harmony with the changing productive potential of the ecosystem.

We should select methods which enable people to assure their livelihood through making use of both traditional knowledge and advanced science. Otherwise the direction of technological developments may solve some immediate needs of its people but it leads to even greater ones. Large section of the population may be marginalized by ill-considered development. During the course of development human interventions in natural systems in the form of settled agriculture, the diversion of water resources, the extraction of minerals, the emission of heat and noxious gases into the atmosphere, commercial forests and genetic manipulation are more threatening to life-support systems both locally and globally. This need not happen. A minimum sustainable development must not endanger the life on earth, the atmosphere, the waters, the soil and the living beings.

The accumulation of knowledge and development of technology can enhance the carrying capacity of energy, materials, water and land. Many of these will manifest themselves in the form of rising costs and diminishing returns rather than in the form of any sudden loss of a resource base. But sustainability requires that long before these are reached, the world must ensure equitable access to the constrained resources and reorient technological efforts to relieve the pressure. Economic growth and development obviously involve changes in the physical ecosystem. Every ecosystem everywhere cannot be preserved intact. A forest may be depleted in one part of a water shed and extended elsewhere, which is not a bad thing if the exploitation has been planned and the effects on soil erosion rates, water regimes and genetic losses have been taken into account. In general renewable resources like forest and fish stocks need not be depleted provided the rate of use is within the limits of regeneration and natural growth. But most renewable resources are part of a complex and interlinked ecosystem and maximum sustainable yield must be defined after taking into account system-wide effects of exploitation.

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As for non-renewable resources like fossil fuels and minerals, their use reduces the stock available for future generations. Therefore the rate of depletion should take into account the criticality of that resource, the availability of technologies for minimising depletion and the likelihood of substitutes being available. Sustainable development requires that the rate of depletion of non-renewable resources should foreclose as few future options as possible.

Sustainable development requires the conservation of plant and animal species because species once extinct are not renewable. The loss of plant and animal species can greatly limit the options of future generations.

Sustainable development requires that the adverse impacts on the quality of air, water and other natural elements are minimised so as to sustain the ecosystem's over all integrity. In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional changes are all in harmony and enhance both current and future potential to meet human needs and aspirations.

4.4. EQUALITY AND COMMON INTEREST

Ecological interactions do not respect the boundaries of individual ownership of political jurisdiction. Thus :

(a) In a watershed, the ways in which a farmer up the slope uses land directly affect run-off on farms downstream.

(b) The irrigation practices, pesticides and fertilizers used on one farm affect the productivity of neighbouring ones, especially among small farms.

(c) The efficiency of factory boiler determines its rate of emission of soot and noxious chemicals and affects all who live and work around it.

(d) The hot water discharge of thermal power plant into a river or a local sea affects the catch of all who fish locally.

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Traditional social system recognised some aspects of this interdependence and enforced community control over agricultural practice and traditional rights relating to water, forests and land. This enforcement of the common interest did not necessarily impede growth and expansion though it may have limited the acceptance and diffusion of technical innovations.

Local interdependence has increased because of the technology used in modern agriculture and manufacturing. Yet with this surge of technical progress, the growing 'enclosure' common lands, the erosion of common right in forest and other resources, and the spread of commerce and production for the market, the responsibilities for decision making are being taken away from both groups and individuals.

Communities or governments should take narrow self-interest which prevents harmful side effects through laws, education, taxes, subsidies and other methods. Most important, efffective participation in decision-making processes by local communities can help them articulate and effectively enforce their common interest. Lack of common interest and interaction cooperation the enforcement of common interest often suffers because areas of political jurisdictions and areas of impact do not coincide.

Many problems arise from inequalities in access to resources. An inequality of land ownership structure can lead to over exploitation of resources in the environment and development. Internationally, monopolistic control over resources can drive those who do not share excessive exploitation of marginal resources. The differing capacities of exploiters to commandeer free goods - locally, nationally and internationally - is another manifestation of unequal access to resources Losers' in environment/development conflicts include those who suffer more than their fair share of the health, property and ecosystem damage (cost of pollution).

As a system approaches ecological limits, inequalities sharpen. Thus when a watershed deteriorates, poor farmers suffer more because they cannot afford the same anti-erosion measures as richer farmers. When urban air quality deteriorates, the poor, in their more vulnerable areas, suffer more health damage than the rich who usually live in more pristine neighborhoods. When mineral resources become depleted late comers to the industrialization process lose the benefits of low cost supplies. Globally, wealthier nations are better placed financially and technologically to cope with the effects of possible climate change.

Hence our inability to promote the common interest in sustainable development is often a product of the relative neglect of economic and social justice within and amongst nations.

4.5. STRATEGIC IMPERATIVE

Critical objectives for environment and development policies that follow from the concept of sustainable development include :

(a) Reviving growth

(b) Changing the quality of growth

(c) Meeting essential needs for jobs, food, energy, water and sanitation

(d) Ensuring a sustainable level of population

(e) Conserving and enhancing the resource base

(f) Re-orienting technology and managing risk and

(g) Merging environment and economies in decision making.

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Reviving Growth : Sustainable development has to address the problem of the large number of people who live in absolute poverty that is who are unable to satisfy even the most basic of their needs. Poverty reduce peoples' capacity to use resources in a sustainable manner; it intensifies pressure on the environment.

Growth must be revived in developing countries because that is where the links between economic growth, the alleviation of poverty and environmental conditions operate most directly. Yet developing countries are part of an interdependent world economy; their prospects also depend on the levels and patterns of growth in industrialized nations. Growth rates could be environmentally sustainable if industrialized nations can continue the recent shifts in the content of their growth towards less material and energy intensive activities and the improvement of their efficiency in using materials and energy.

As industrialised nations use less materials and energy, however, they will provide smaller markets for commodities and minerals from the developing nations. Yet if developing nations focus their efforts upon eliminating poverty and satisfying external human needs, then domestic demand will increase for some services. Hence very logic of sustainable development implies an internal stimulus to third world growth.

Nonetheless, in large number of developing countries, markets are very small and for all developing countries high export growth especially of non-traditional items, will also be necessary to finance imports, demand for which will be generated by rapid development. Thus a reorientation of international economic relations will be necessary for sustainable development.

Changing the quality of growth : Sustainable development involves more than growth. It requires a change in the content of growth, to make it less material and energy intensive and more equitable in its impact. These changes are required in all countries as part of a package of measures to maintain the stock of ecological capital, to improve the distribution of income, and to reduce the degree of vulnerability to economic crisis.

The process of economic development must be more soundly based upon the realities of the stock of capital that sustains it. Similar incomplete accounting occurs in the exploitation of other natural resources especially in the case of resources that are not capitalised in enterprise or nation accounts: air, water and soil. In all countries rich or poor, economic development must have taken full account in its measurement of growth of the improvement or deterioration in the stock of natural resources.

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Income distribution is one aspect of the quality of growth and rapid growth combined with deteriorating income distribution may be worse than slower growth combined with re-distribution in favour of the poor. For instance, in many developing countries the introduction of lage scale commercial agriculture may produce revenue rapidly, but may also dispossess a large number of small farmers and make income distribution more inequitable. In the long run such a path may not be sustainable.

A development path that combines growth with reduced vulnerability is more sustainable than one that does not increase vulnerability. It will lead to many types of crisis and management of crisis Technics have to be adopted according to the type of crisis.

Sustainability requires inclusion of human needs and well being that incorporate both economic and non-economic variables. Non-economic variables such as education and health, clean air and water and the protection of natural beauty. It must also work to remove disabilities from disadvantaged groups, many of whom live in ecologically vulnerable areas, such as many tribal groups in forests, deserts and nomads in remote hill areas.

Changing the quality of growth requires changing our approach to development efforts to take account of all their effects. For instance, a hydropower project should not be seen merely as a way of producing more electricity, its effects upon the local environment and the livelihood of the local community must be included in any balance sheet.

Economic and social development can and should be mutually reinforcing. Money spent on education and health can raise human productivity. Economic development can accelerate social development by providing opportunities for under privileged group or by spreading education more rapidly.

Meeting Essential Human Needs : The principal development challenge is to meet the needs and aspirations of an expanding developing world population. The most basic of all needs is for a livelihood that is employment. The pace and pattern of economic development have to generate sustainable work opportunities on this scale and at a level of productivity that could enable poor households to meet minimum consumption standards.

More food is required not merely to feed more people but to attack undernourishment though the focus at present is necessarily on staple foods - high rate of growth of protein availability. But increased food production should not be based on ecologically unsound production policies and compromise long term prospects for food security.

Energy is another essential human need that cannot be universally met unless energy consumption pattern changes. The most urgent problem is the requirements of poor. Third World households depend mainly on fuel wood for their energy needs. By the turn of the century 3 billion people may live in areas where wood is cut faster than it grows or where fuel wood is extremely scarce. Corrective action would both reduce the drudgery of collecting wood over long distance and preserve the ecological base.

The linked basic needs of housing, water, supply sanitation and health care are also environmentally important. The failure to meet these key needs is one of the major causes of many communicable diseases such as malaria, gastro-intestinal infections, cholera and typhoid.

Ensuring a sustainable level of population : The sustainability of development is intimately linked to the dynamics of population growth. High population size is a greater burdern on the earth's resources. The greater part of global population increase will take place in developing countries where the 1985 population of 3.7 billion may increase to 6.8 billion by 2025. The third world does not have the option of migration to new lands and the time available for adjustment is much less than industrial countries had. Hence the challenge now is to quickly lower population growth rates.

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Birth rates declined in industrial countries largely because of economic and social development. Rising income and urbanization and the changing role of women all played important roles.

Cities in developing countries are growing much faster than the capacity of authorities to cope. Uneven distribution of rural and urban population and shortage of housing water, sanitation and mass transit are widespread. Further it leads to air and water pollution and to industrial and natural hazards.

Conserving and Enhancing the Resource Base : If needs are to be met on a sustainable basis the Earth's natural resource base must be conserved and enhanced. However, the case for the conservation of nature should not rest only with development goals. It is part of our moral obligation to other living beings and future generation.

Pressure on resources increases when people lack alternatives. Development policies must widen people's options for earning a sustainable livelihood, particularly for resource poor households and in areas under ecological stress.

The conservation of agriculture or agricultural resources is an urgent task because in many parts of the world cultivation has already been extended to marginal lands and fishing and forestry resources have been over exploited. These resources must be conserved and enhanced to meet the needs of growing populations. Land use in agriculture and forestry should be based on a scientific

assessment of land capacity and the annual depletion of top soil, fish stock or forest resources must not exceed the rate of regeneration. Increases in productivity in both developed and developing countries should be based on the better controlled aplication of water and agrochemicals as well as on more extensive use of organic manures and non-chemical means of pest control. These alternatives can be promoted only by an agricultural policy based on ecological realities to avoid loss of genetic diversity in standing crops, salinization and alkalization of irrigated lands, nitrate pollution of ground water and pesticide residues in food.

Over exploitation of fisheries and topical forest of the naturally available stocks, the sustainable yield from these stocks may well fall short of demand. Hence it will be necessary to turn to methods that produce more fish, fuel wood and forest products under controlled conditions. Subsitutes for fuel wood can be promoted. The ultimate limits to global development is perhaps determined by the availability of energy resources and by the biosphere's capacity to absorb the byproducts of energy use. These energy limits may be approached far sooner than the limits imposed by other material resources. First, there are the supply problems. The depletion of oil resources, the high cost and environmental impact of coal mining and the hazards of nuclear technology. Secondly, there are emission problems, acid pollution and carbon dioxide build up leading to global warming.

Some of these problems can be met by increased use of renewable energy resources. But the exploitation of renewable resources such as fuel wood and hydropower also entails ecological problems. Hence sustainability requires a clear focus on conserving and efficiently using energy.

The prevention and reduction of air and water pollution will remain a critical task of resource conservation. Air and water quality come under pressure from such activities as fertilizer and pesticide use, urban sewage, fossil fuel burning, the use of certain chemicals and various other industrial activities.

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Reorienting Technology and Managing Risk : For the sustainable development technology innovation needs to be greatly enhanced in developing countries so that they can respond more effectively to the challenges of sustainable development and the orientation of technology development must be changed to pay greater attention to environmental factors.

The technologies of industrial countries are not always suited or easily adaptable to the socio-economic and environmental conditions of developing countries. These gaps must be covered by enhancing research design, development and extension capabilities in the third world countries.

In all countries the processes of generating alternative technologies, upgrading traditional ones and selecting and adapting imported technologies should be informed by environmental resource concerns. Technologies are needed to produce 'social goods' such as improved air quality or increased product life.

The role of policy is to ensure, through incentives and disincentives, both commercial organisations and publicly funded research institutions find it worthwhile to take fuller account of environmental factors in technologies they develop.

The development of environmentally appropriate technologies is closely related to questions of risk management. Such systems as nuclear reactors, electric and other utility distibution networks, communication systems and mass transportation are vulnerable if stressed beyond a certain point.

There is thus a need for new techniques and technologies as well as legal and institutional mechanisms for safe design and control, accident prevention, contingency planning, damage mitigation and provision of relief.

National and international institutional machanisms are needed to assess potential impacts of new technologies before they are widely used, in order to ensure that their production, use and disposal do not overstress environmental resources. Similar arrangements are required for major interventions in natural systems such as river diversion or forest clearance.

Merging Environment and Economics in Decision Making : The common theme throughout this strategy for sustainable development is the need to integrate economic and ecological considerations in decision making. Economic and ecological concerns are not necessarily in opposition. For example, policies that conserve the quality of agricultural land and protect forests improve the long term prospects for agricultural development.

Intersectoral connections create patterns of economic and ecological interdependence rarely reflected in the ways in which policy is made. Sectoral organisation tend to pursue sectoral objectives and to treat their impact on the environment and development problems that confront us how their roots in this sectoral fragmentation of responsibility. Sustainable development requires that such fragmentation be overcome.

Sustainablility requires the enforcement of wider responsibilities for the impacts of decisions. This requires changes in the legal and institutional frameworks that will enforce the common interest and principally needs community knowledge and support which entails greater public participation in the decisions that affect the environment. This is best secured by decentralizing the management of resources upon which local communities depend and giving these communities an effective say over the use of these resources. It will also require promoting citizen initiatives, empowering people's organisations and strengthening local democracy.

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When the environmental impact of a proposed project is particularly high, public scrutiny of the case should be mandatory and whenever feasible, the decision should be subjected to prior public approval, perhaps by referendum.

Environmental regulation must move beyond the usual menu of safety regulations, zoning laws and pollution control enactments; environmental objectives must be built into taxation, prior approval procedures for investment and technology choice, foregin trade incentive and all components of development policy.

The integration of economic and ecological factors into the law and into decision-making systems within countries has to be matched at the international level. Economic interactions through trade, finance, investment and travel will also grow and heighten economic and ecological interdependence.

4.6. CONCLUSION

In its broadest sense, the strategy of sustainable development aims to promote harmony among human beings and between humanity and nature. The pursuit of sustainable development requires :

(a) A political system that secures effective citizens participation in decision making

(b) An economic system that is able to generate surplusses and technical knowledge in a self-reliant and sustained basis

(c) A social system that provides for solutions for the tensions arising from disharmonious development

(d) A production system that respects the obligation to pressure the ecological base for development

(e) A technological system that can search continously for new solutions

(f) An international system that can search contiuously for new solutions

(g) An international system that fosters sustainable patterns of trade and finance and

(h) An administrative system that is flexible and has capacity for self-correction.

These requirements are more in the nature of goals that should underlie national and international action on development.

Check Your Progress - 1

What are the cirtical objectives for environment and development policies that follow from the concept of sustainable development?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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4.7. SUMMARY

Development is nothing but the transformation of economy and society. The path of development is sustainable in a physical sense. Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Development involves a progressive transformation of economy and society.

Poverty and inequality are endemic and will always be prone to ecological and other crisis in the developing countries. The essential needs of vast numbers of people for food, clothing, shelter and jobs are not being met. Sustainable development requires the promotion of values that encourage consumption standards.

Local interdependence has increased because of the technology used in modern agriculture and manufacturing. Many problems arise from inequalities in access to resources. As a system approaches ecological limits, inequalities sharpen.

Critical objectives for environment and development policies that follow from the concept of sustainable development include reviving growth, changing the quality of growth, meeting essential needs for jobs, food, energy, water and sanitation, ensuring a sustainable level of population, conserving and enhancing resource base, reorienting technology and managing risk and merging environment and economies in decision making.

In its broadest sense, the strategy of sustainable development aims to promote harmony among human beings and between humanity and nature.

4.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The critical objectives for environment and development policies that follow from the concept of sustainable development are: (a) reviving growth, (b) changing the quality of growth, (c) meeting essential needs for jobs, food, energy, water and sanitation, (d) ensuring a sustainable level of population, (e) conserving and enhancing the resource base, (f) reorienting technology and managing risk and (g) merging environment and economies in decision making.

4.9. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Write briefly about the concept of sustainable development.
2. Briefly write on equality and common interest.
3. What are the critical objectives for environment and development policies that follow from the concept of sustainable development? Explain each one of them.

II. Answer the following questions in about 10 lines each.

1. Write briefly about sustainable development and quality of life.
2. Write briefly on the relationship between promotion of values and sustainable development.
3. What measures do you take for reviving growth?
4. How do you change the quality of life?
5. How do you meet the essential needs of human beings?
6. Write briefly about sustainable level of population.
7. How do you conserve and enhance resource base?

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UNIT-5 : STUDY OF NATURAL RESOURCES

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5.7. Model Examination Questions

5.1. OBJECTIVES

After going through this unit, you will be able to :

* classify natural resources
* describe the Club of Rome model and its predictions about natural exhaustion.
* list out and describe various Neo-classical based theories of Natural resources depletion.
* explain the methods of management of Natural Resources at local, national and international levels.

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5.2. INTRODUCTON

Natural Resources (NR) are classified into i) Renewable and ii) Non-renewable resources.

Renewable Resources (RR), such as flora and fauna can regenerate themselves and grow. Though not strictly renewable, perennial resources like sunshine, soil, water and the atmosphere, are assumed to last as long as the Earth exists. While the amount of sunshine cannot be reduced or polluted through Man's activities, the other three can, through mismanagement. Even though the amount of sunshine is constant, its spread and intensity is affected by various types of pollution which cause depletion of the ozone layer, or the increase in carbondioxide leading to thermal pollution. Soil though capable of rejuvenation, is subject to erosion, its fertility affected by mismanagement, and it can be polluted and exhausted. Water can also be polluted. Although the total stock of water on Earth is constant, the water cycle (rains and the water table), can be adversely affected by the thermal pollution, greenhouse effect and mismanagement. The composition of the atmospheric gases is also affected by pollution, leading to increase in carbon dioxide and carbon monoxide, sulphuric acid and other acids. The oxygen levels and the ozone layer are also being depleted.

Although renewable resources can grow back, they are also capable of being exhausted, if their rate of exploitation exceeds their rate of reproduction. For e.g., in a forest, if trees are cut down faster than new ones can grow, it leads to deforestation.

Non-renewable Resources (NRR), by their very nature cannot grow back. Metals, minerals and fossil fuels are incapable of regenerating themselves, and the continuous depletion mining ultimately leads to their exhaustion. Mines, such of coal, copper or oil wells, when exhausted cannot regrow the minerals. Once exhausted, they stay exhausted. Fossil fuels, such as coal, oil, gas, are once-for-all resources, which when burnt cannot be recycled. While metals can theoretically be recycled, minerals cannot, as they do not exist in the free state. Minerals usually occur in their compound form and undergo chemical changes during production and use. Hence it is more difficult to recover them, unless further chemical changes are introduced.

Man converts NRs into various goods (final and intermediate) for his own use. During extraction, production and consumption, the NRs are subject to a number of changes and processess, which let off wastes. As economies grow, production increases leading to more exploitation of NRs. However, the total stock of NRs on Earth is finite, while Man's demand for goods is increasing infinitely. This will ultimately lead to the exhaustion of NRs, accompained by rising pollution. Both these factors affect environmental quality, ultimately affecting Man himself.

Various theories have been formulated analysing the nature of NR depletion. We shall take up the study of these theories, starting with the most famous study of the Club of Rome, the Limits to Growth.

5.3. THEORIES OF NATURAL RESOURCES DEPLETION

5.3.1. Limits to Growth

The basic objective of the Club of Rome model is to determine whether the growth of population and capital accumulation can be sustained in the future - if so, then, "how many people, at what level of wealth, and for how long?"

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The author points out that population on a global scale is increasing, and so also is the consumption requirements per head. Production of consumption and capital goods requires NR inputs. During the process of production and consumption, wastes are released, which cause pollution. The faster the rate of growth of the world economies, the faster the rate of depletion of NRs, and greater the release of pollution. Since the supply of NRs is finite, as also the capacity of the environment to absorb and assimilate pollution, these would soon impose limits to the further growth of the economies of the world. Thus the present pattern of development is unsustainable on a global level. A finite Earth cannot support infinite growth.

The study focusses attention on two basic aspects of a growing system :

a) No variable grows in isolation, for each growing system is connected to others in various highly complicated ways. On a global scale especially, each growing system affects others, and is in turn affected by them. Such reactions are known as "multiple-feed back loops". For e.g., as population grows, food requirements increase. But arable land is not only finite, but its demand for non-agricultural purposes is also increasing. (In USA demand for land for non-agricultural uses was 0.8 hect/head, while arable land was 0.4 hect/head in 1972). With an increasing demand for food, and shrinking supply of arable land, food production can grow only through greater mechanisation, which requires growth of capital. Industrial growth requires increasing inputs of NRRs, whose reserves are finite and non-renewable. The byproduct of growth is pollution, as pollution levels are increasing, population and output are affected.

b) Exponential growth leads to the doubling of the growing variable at specific intervals. For e.g., if a mineral is growing at 10% p.a. and the initial amount mined was 100 tonnes, in the first year, then in 7 years time it would have become 200 tonnes, in 14 years - 400 tonnes, 800 tonnes in 21 years and so on. This can be better explained in the following way.

Quantity : (000 tonnes)	100	200	400	800	1600	3200	6400	12800
Time(years) (approx.)	0	7	14	21	28	35	42	48

After 10% rate of growth p.a. the output of the mineral has increased by 128 times in less than half a century. The intitial amount mined being 100,000 tonnes, at the end of 48 years the quantity mined would be 12,800,000 tonnes. This shows the suddenness with which the growing amount reaches extremely large magnitudes. The doubling time of different growth rates are given below.

Growth : p.a.(%)	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
Doubling (approx.)	72	36	24	18	14.4	12	10.2	9	8	7.2

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It can be seen that the higher the rate of growth, the lower the doubling period. Hence growth rates are very misleading, what has to be highlighted is the quantity of the growing variable and the doubling time. The size of the mineral extracted looks quite innocuous, but in one doubling time, it attains unmanageable size. In the above example if the reserves of the mineral was 15,000,000 tonnes, then it is normally assumed that at the present output level of 100,000 tonnes, the reserve will last for 150 years, i.e. 15,000,000/100,000. But the estimate shows that the growth rate of mineral is 10% p.a. with the result that the limits will be reached in only 48 years, and the reserves will not last for the next doubling period.

The model uses the method of System Dynamics to analyse and predict the effect of these two aspects of growth in the world. System Dynamic was developed by Jay Forrester at MIT. and is used to analyse the dynamic behaviour of complex systems. The methodology takes into account the structure of the system - i.e., the many circular, inter locking, sometimes delayed relationships among the various variable being analysed as being as important in determining its behaviour, as the individual components themselves. Five interrelated and growing systems are analysed - population, food production, industrial growth, depletion of non-renewable resources and growth of pollution.

As explained earlier, a growing population requires more food. The supply of arable land is shrinking, as the demand for non-arable land increases. To augment the supply of food, increasing mechanisation is needed. The demand for capital leads to increase in industrial output. But industrial production requires non-renewable resources and releases pollution. The stock of non-renewable resources is finite, and at exponential rates of depletion the limits will soon appear. Pollution also grows exponentially, and the environment will be unable to assimilate the pollution. Pollution will affect both population as well as food production. Using System Dynamics, the

possible scenario that will result if present trends in these growth rates continue, is then projected. But before discussing that, we need to look at another concept - the Exponential Reserve Index.

The Exponential Reserve Index : Usually the life time of a mineral is estimated by dividing the total reserves by the current year's production. For e.g., in 1970, chromium reserves were assumed to last for 420 years.

But according to the exponential Reserve Index, the possible date of exhaustion of the most important minerals were workd out. According to their estimate, at present rates of depletion, the world will run out of its major minerals within the next hundred years. The known global natural reserves are given in Table 5.1.

Table 5.1. The Known Global Natural Reserves

Resource	Known Global Reserves		Static Index (years)	Average Growth Rate (% p.a)	Exp.index (years)	Reserves increased 5 times
Natural gas	$1.14x10^{15}$	cu.ft	38	4.7	22	49
Petroleum	$455x10^{9}$	bbls	31	3.9	20	50
Tin	$4.3x10^{6}$	lgtons	17	1.1	15	61
Aluminium	$1.17x10^{9}$	tons	100	6.4	31	55
Chromium	$7.75x10^{8}$	tons	420	2.6	95	154
Coal	$5x10^{12}$	tons	2300	4.1	111	150
Iron	$1x10^{11}$	tons	240	1.8	93	173

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The Static Reserve Index gives a more optimistic picture, as it does not take note of the exponential growth of the resource. Even if reserves increase by five times the present level, the limits will not be pushed back five times, but only marginally (Column 6 of the table). Hence attempts to increase the reserves through exploration, new discoveries, and through recycling and improvements in technology, will not push back limits infinitely, since growing levels of depletion will eat into the reserves.

Exponential growth affects the other growing systems as well. The interaction and feedback of the five growing systems on each other have been depicted through computer simulation. Different scenarios have been depicited, showing the possible outcome of the growth of different systems. Using present growth rates and reserves position, the first scenario called The Standard Run Model forecasts that there will a collapse of the world economies within the next century, because of exhaustion of NRRs and limits to food production.

Different scenarios are next drawn up, based on different assumptions rgarding the systems under study. For instance, can collapse be averted if there are unlimited supplies of NRRs? But here increasing pollution becomes the limiting factor. Similarly, other assumptions are made and

different scenarios projected. However, they all show that some crisis will occur, either because of over population, over exploitation, food shortages or pollution. The only scenario that ensures equilibrium through continued and sustained growth, is where the growth of population and capital is zero - stability in population growth by equating the birth rate with the death rate, and of capital, where growth equals depreciation. In Economics, this is akin to the concept of the Stationary State. Even here depletion of NRRs takes place as also pollution, but these are so slow that there is time for corrective action to be taken if necessary. There is time to look for substitutes, improve technology, and for proper precautions to be taken.

The State of Global Equilibrium would be one of which growth is sustainable, and a higher standard of material living is achieved for a stable population. It is characterised by (i) zero growth rates of population and capital plant, (ii) all input and output leads - births, deaths, investment and depreciation - are kept at the minimum, and (iii) the levels of capital and population and the ratio of the two are set in accordance with the values of society.

Limitations

(1) The model is depicted in aggregate terms, which marks the differences in the consumption of NRRs by the developed and the underdeveloped countries. The industrialised countries consume the bulk of the world's resources, having only 6% of the world's population consuming around 60-80% of the world's NRRs. On the other hand, the Third World Countries which produce about 60-80% of the NRRs, get a very minor share in their consumption and use.

(2) The Policy prescription for sustained growth, is to freeze growth rates to zero. This policy would be unfair to the Third World Countries, which have low standards of living, high levels of poverty and low growth rates. Zero growth would destroy their chances to improve the standard of living of their population. With all growth rates levelled off, the distribution of assets, incomes and consumption, would be in favour of the industrialised countries. Unless zero growth is accompained by massive redistribution of wealth from the former to the non-industrialised countries, social justice cannot be achieved globally.

(3) It is the life-style, consumption pattern and technology of the industrialised countries that have triggered off the environmental crisis. But the policy prescribed by the model does not aim at reducing their consumption rates and levels. Instead it tries to perpetuate the same pattern of growth and consumption for all countries for all times to come. The policy does not recommend reduction in the standard of living and consumption pattern of the industrial nations.

(4) Economists criticise this model on the grounds that resources will not run out suddenly, but with increasing scarcity, prices will rise as cost of production of resources increases. The increase in prices will act as a signal for fresh discoveries as more exploration takes place, substitutes for the minerals will emerge, more technical advancement will take place to mine more efficiently, as also recycling and recovery of the resources. Hence all this will increase the supply, and the higher prices will reduce the demand for the scarce resource.

Check Your Progress - 1

Explain the nature of exponential growth. How does it affect the rates of depletion of NRRs?

Note : (a) Write the answers in the space provided below.

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(b) Compare your answers with those given at the end of this unit.

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5.3.2. Theories of NR Depletion Based on Neo-classical methodology

The "limits to growth" approach to resource depletion is often compared to the "Malthusian Theory". Malthus in 1798, pointed out that while population has a tendency to increase exponentially, food production could only grow at a linear rate. The limit to growth would be the finite quantity of arable land. In Environmental Economics, this concept is termed the Absolute Physcial Scarcity.

Another school of thought is based on Ricardo's analysis which envisages a more optimistic picture of resource depletion. Resources do not suddenly get exhausted, but become more difficult to exploit. This results in increasing costs and prices of the resources, as extraction companies have to spend more to exploit lower grade ores. The rising costs will lead to two results : (1) it will lead to exploration for new reserves, and improved technical methods to increase the efficiency of extraction. (2) Rising costs and prices of the resources, will cause consumers to shift to substitutes and increase efficiency in use through recycling etc. This approach is termed the Relative Scarcity Approach. Let us now look at the analysis of NR depletion based on the Relative Scarcity principle. The methodology followed here is based on Neo-classical Economic assumptions. These include the assumption of perfect competition, wherein no single producer or consumer can affect the market price, which is given by the total demand and supply of the commodity in the market. Secondly, there is perfect knowledge regarding demand conditions, prices, rate of interest, costs etc. Unlike the usual analysis of perfect competition, which involves only present decisions, the analysis of resources depletion involves the future - i.e. should the resources be exploited now, or in the future? We shall look into the theories of optimum resources depletion of (1) Renewable resources and (2) Non-renewable resources.

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Optimal Depletion of Renewable Resources : Renewable resources can be exploited in a sustainable manner, if the rate of exploitation is less than or equal to the rate of reproduction. Let us take a very simple example of fish in a pond. Assume that there are 1000 fish in the pond at the beginning of the year, and that they grow at 10% a year. At the end of the year, there are 1100 fish in a pond. If only 100 fish are caught, then the remaining 1000 fish can again grow at 10% and so on. The growth of the fish is called the 'yield' and the catch of 100 fish, which leaves the stock of fish at the former level constant, is called the 'sustainable yield'. At this level of fishing (or harvesting), fishing is sustainable, other things remaining constant. A large catch will deplete the stock of fish, and decrease it. If 200 fish are caught, then this leaves only 900 fish as stock. At the rate of reproduction of 10% only 90 fish are added to the stock at the end of the year. If 250 fish are caught next year, (either because of the entry of new fishermen, or improvements in fishing techniques), the stock depleted to 740, i.e. 990-250. This would go on till the entire stock of fish is depleted. Hence it is necessary to equalise the rate of exploitation with the rate of reproduction of renewable resources, if optimal levels of depletion have to be achieved.

The yield depends on the size of the stock, as the size shrinks, so does the rate of reproduction. The larger the stock, the higher the reproduction rate, for instance if there are 1000 fish, they can grow at 10%. When stocks become very meagre, they become **non-viable** and reproduction does not take place - this is called the **critical minimum size** of the stock. Below this minimum, the stock is likely to die out without reproduction. Many species are lost because people get alarmed only when this critical stage is reached, and it becomes too late to conserve it. As a species dies out, the **habitat** is also affected, and is incapable of supporting other species. This is because the different species and the environment in which they live, act as a check on each other - Nature's balance is destroyed.

Natural equilibrium is achieved when death rates equal birth rates, so that the **carrying capacity** of the environment is maintained. For instance, let us assume that for some reason the stock of fish has fallen below its maximum size, but not below the critical minimum. Now birth rates will increase, and the fish population will increase, since food and space per capita are more. But the rate of growth slows down as the increasing fish compete for the existing food supplies. The yield then reaches a mximum - the **Maximum Sustainable Yield (MSY)** - after which it declines, till it reaches zero. This occurs when the stock of fish has reached its **carrying capacity**. Any further increase in stocks leads to more fish dying from lack of food resources. Hence, left to itself Nature restores the balance by increasing births when stocks are low, and increasing deaths as the stock exceeds the carrying capacity of the environment. This exercise occurs in all naturally growing species.

Time and Discounting : The above analysis assumes no change in time, i.e. it is a static analysis. When 'time ' is taken into account two aspects have to be considered - (1) time preference, i.e. we prefer to enjoy benefits now rather than wait for the future, and (2) growth in capital value, i.e. if we invest our income instead of spending on consumption, we can earn interest on it. In both cases the future is discounted at a positive rate.

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The same principle is applied to the harvesting of renewable resources. If the fish is caught and sold, the profits can be enjoyed now. But if the fish is left in the pond, they will reproduce themselves, more can be caught in the future and more profits will be earned in the future since prices also increase in future. The fisherman has to now decide if he would prefer to catch the fish now, or wait for the future to earn more. The following formula would help him to decide :-

Discount rate = Biological rate of growth + growth in capital value.

The Biological Rate of Growth is the rate of reproduction i.e. yeild, while the growth in capital value is the possible appreciation in the value of the fish because of increasing prices, if they are left in the pond for harvesting in the future. The question of whether to catch the fish now or leave them for the future, depends on the rates of growth of the fish, of the discount rate and of future expected prices. Assume that the rate of growth of fish is 3% p.a., the discount rate is 10% and prices are increasing at 5%. The decision to be taken is between catching 100 tonnes of fish at Rs.100 per tonne now, or catching them in future, Which would yield higher benefits?

Value	Fish now	Fish in future
Revenue	Rs. 10,000	Rs. 10,815.00
Discounted Value	Rs. 10,000	Rs. 9,831.81

If 100 tonnes are caught now, the revenue earned will be Rs.10,000 (100 tonnes x Rs. 100 a tonne). If the fisherman waits for one year, then the fish grows at 3%. it would be 103 tonnes next year. Prices are expected to grow at 5% so that each tonne now sells for Rs.105, and the total revenue would now be Rs.10,815. However this is not the true value, it has to be discounted by 10%. The future value of Rs.10,815 divided by the dicount rate 1.1 (i.e.,10815 / 1.1) = 9831.81. Since the present value of Rs. 10,000 is greated than the future value of Rs. 9831.81, it would be more possible to catch the fish now. If the discount rate is greater than the combined growth rate plus capital gain then it is better to harvest now. If on the other hand it is lower, then it is better to postpone the catch, for e.g., if the discount rate is 6%, then 6% < 5% + 3%). Clearly, the future rate of earning is greater than the present, and it is better to wait. If the rate of discount equals the rate of growth plus capital gains (8%), then the same value of Rs.10,000, obtains both now and in the future, and it does not matter when the fish is harvested. Hence, if society places greater significance on the present rather than on the future, a high discount rate is used, leading to faster exploitation of the resources. This explains why many rare species, such as snow leopards, tigers, elephants, rhino, etc., are hunted to the point of extinction, because the present value of the resource is valued higher than the value of conservation. The species is driven to extinction by an additional factor - the rate of reproduction of these rare species is very low, while they are hunted at increasingly growing rates.

Check Your Progress - 2

What is meant by the term "the tragedy of the commons"? Why does it occur?

Note : (a) Write your answer in the space given below.

(b) Compare your answer with the one given at the end of this unit.

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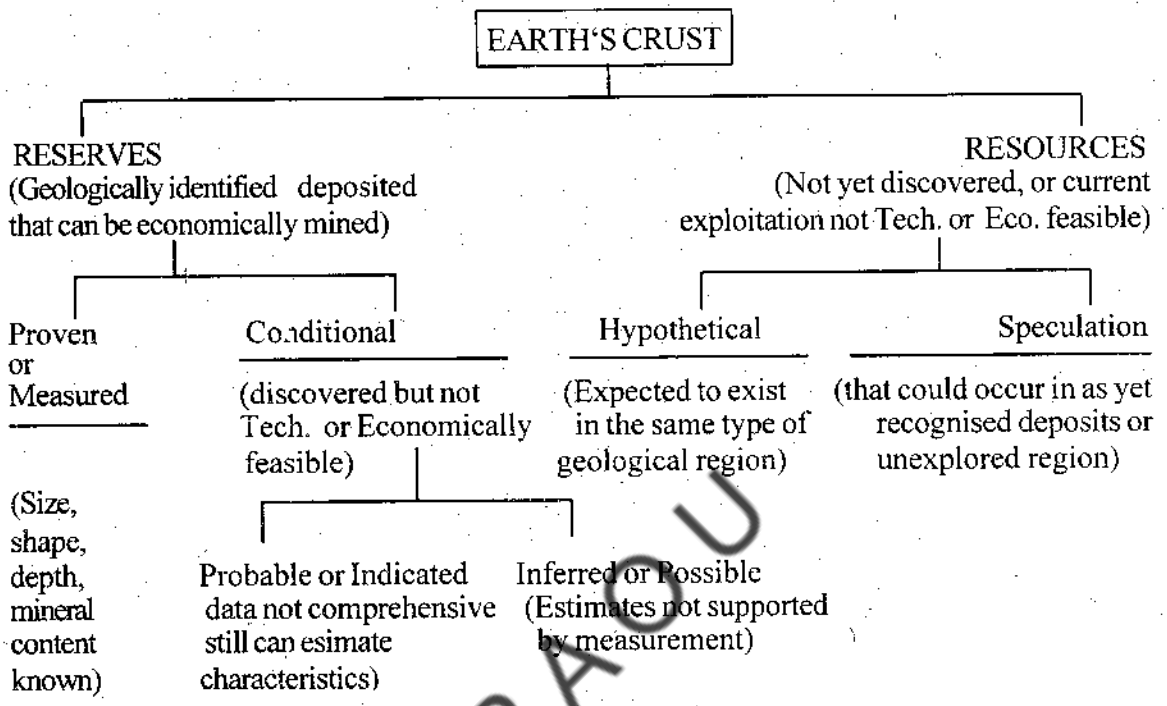
Optimum Rates of Depletion of Non-Renewable Resources :

Since non-renewable resources do not 'grow', the concept of 'sustainable yield', does not apply to them. instead the question is the rate at which NRRs are to be depleted, and the amount to be extracted.

The Club of Rome had pointed out that there would be an ultimate limit to economic growth caused by the exhaustion of NRRs. This approach is akin to the Malthusian Theory of Population. However, some economists argue that the Earth will not suddenly run out of resources, but that NRRs will progressively become scarce, and difficult to exploit. Hence the cost of exploitation increases, as more and more is spent on extraction of inferior grade ores, and on exploration. As costs and prices increase, the demand for these costly minerals falls, there is a shift to substitutes and more efficient ways of resource usage and recycling. Such an argument is based on the Ricardian Theory of Land, which states that as population grows, inferior lands are brought under the plough, leading to lower growth in output of food. Hence land is always available at the margin, though of an inferior quality. NRRs are thus assumed to become 'scarce' not exhausted',

as the margin can always be extended through further exploration. Scarcity can thus be depicted in terms of (a) Physcial scarcity indicators and (b) Economic scarcity indicators.

(a) **Physcial indicators :** Estimates regarding the size of NRRs keeps changing. The physical measure of scarcity is based on actual geological data on NRRs, with some forecast on their demand. The reserves estimates, followed by the Geological Survey of USA, is based on the McKelvey's system. The following table depicts the classification of reserves and resources.



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Proven Reserves : Depend on five major and related factors, which are highly dynamic in nature. These are: (a) Technological knowledge and skills (b) Production and processing costs (c) Demand levels (d) Price of the resource product and (e) The availability and price of substitutes. Any change in these five variables would result in changes in the estimates of the reserves position.

Conditional Reserves : However here also a change in any of the above five factors affects the reserves position. 'Indicated reserves' are those which have not been intensively surveyed, but projected on the basis of survey data and reasonable geological sites. 'Inferred reserves' are those that have been located, but remain unexplored. These are estimates based on the likely geological conditions of the area.

Hypothetical Resources : These are not known deposits, but those which we may expect to find in future in areas that have been only partially surveyed and developed. For e.g., there are some 600 sedimentary basins in the world today, that have the potential for oil and gas. But explorations have taken place in hardly 1/3 of them. For e.g., sites in the North Sea oil deposits have not been fully explored, but based on present oil production more such sites could easily exist.

Speculative resources : Are even more difficult to estimate. These are deposits which could be found in hitherto unexplored or little explored areas, which have the necessary geological conditions. For instance, China, SE Asia, Africa and Latin America have not been fully explored for oil.

Economic Indicators of Scarcity : Theories of NR depletion take into account the economic indicators to analyse how NRRs can be optimally depleted over time. The decision to extract the

NRR depends on (a) the real cost of production i.e. cost of inputs required to extract and process a unit of the resource output. (b) the actual prices of the resource, (c) shadow prices - prices imputed on the unobservable user cost of the resource - i.e. the foregone value of using a resource now rather than that in the future.

Optimal Rate of Depletion of NRRs : As in the case of the RRs, we assume perfect competition, i.e. the price of the NRR is given, and a free enterprise system. A mine-owner has to decide whether he should extract the resource now, or postpone its extraction for the future. However, unlike other types of goods, extraction of the mineral in future is not independent of the extraction at present. Current extraction can affect the level of reserves available in two different and opposite ways. As extraction increases, the level of reserves decreases for a specific deposit. At the same time, the falling reserve position can lead to increase in exploration and technological improvements, that would increase the level of future reserves.

The actual amount of the resource extracted depends on the capital gain and the rate of discount. Since NRRs do not 'grow', the level of extraction depends on :

Growth in Capital Value = Discount Rate.

This is called the simple Hotelling rule (as it is based on Hotelling's analysis in 1931). Here it is assumed that extraction costs are zero. NRRs in the ground are treated as capital assets, whose prices increase over time - capital gain. If the increase in capital gain equals the rate of discount i.e., the rate of interest, the owner of the mine would be indifferent between extracting the resource now, or conserving it for the future. Here the prices of the resource in the ground, called royalty or rent, equals the price of the extracted resource, called wellhead price. But if there are positive extraction costs, then the two prices will differ. Since the amount of the mineral in the ground is finite, an additional cost has to be taken into account - the user's cost, which is the opportunity cost of current extraction on future profit. For e.g., a tonne of copper mined now cannot be again extracted in future and sold at a profit at the prices prevailing then. This 'lost' future profit caused by the reduction in the quantity of the mineral is as real a cost to the mine owner as the monetary cost of extraction. Therefore :

Extraction costs = User cost + Monetary cost of extraction.

Optimal price = Extraction cost + User cost

The resource owner will try to maximise total profits (Revenue-Costs), over some time horizon, and will select that rate of extraction, as well as the level of extraction that maximises the present value of the discounted stream of profits. If future prices of the mineral are expected to rise, then less will be exploited now, or if extraction costs were expected to fall because of improvements in technology. These will reduce the amount and increase the time over which the resource is exploited. An increase in the rate of discount, on the other hand would lead to increase in the rate of exploitation, since current profits would be more than future expected profits.

Check Your Progress - 3

Distinguish between 'economical' and 'physical' indicators of NRR reserves.

Note : (a) Write the answers in the space provided below.

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(b) Compare your answers with those given at the end of this unit.

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5.4. NATURAL RESOURCE MANAGEMENT

The theories of NR depletion discussed so far are (1) Club of Rome's Aggregate Global Model, and (2) Micro-economic Perfect Competition Models of RR and NRR depletion. However, both approaches have limitations in applications to real life problems. We have already discussed the limitations of the Club of Rome model. In the case of the Neo-classical theories of Depletion, it has been pointed out that the market is an imperfect allocator of NRs. Perfect competition requires that the market be comprised of a large number of firms (mine owners), acting in a rational way to maximise profits and with omniscent powers to predict future resource demands and price levels. Also there should be no government intervention.

In the absence of knowledge about future demand and prices i.e., uncertainty, the future would be discounted at very high rates, leading to a faster rate of exploitation. Compared to other goods, the prices of raw materials have risen very slowly. This has caused an increase in present rates of extraction, as future prices are not expected to increase. Moreover extraction firms are neither small-scale ones nor are they in large numbers that perfectly competitive markets require. Mining has become a highly mechanised, and large-scale operation, which can be handled by a few multi-national companies, or by Government. Especially when multi-national firms exploit resources in Third World Countries, the lack of political stability and other forms of uncertainty caused faster rates of exploitation. Cartels, formed by groups of countries producing the same resource (e.g., OPEC), can also exploit the world markets. The market system cannot prevent the exhaustion of specific mineral deposits. Usually the resource extraction costs increase as the mines get progressively depleted, so that it becomes uneconomical to mine the resource, unless prices are allowed to rise. But in perfect competition, the individual producer cannot influence the price, hence the mine has to be abandoned, if the production costs rise above the price.

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In actual practice, the proper management of NRs can be better tackled by the local, national and international agencies than by market faces. Wasteful use of NRs stem from three sources: (a) Unrepresented price signals (b) Faculty decision making and (c) Externalities. In the first case, government may subsidise NR inputs, so that low prices lead to over exploitation and misuse of resources. In the second case, private managements are interested only in current profits, so that resources tend to be overexploited and exhausted. In case of Government management, the bureaucratic public sector is insensitive to the finer points of conservation. Ignorance, inertia and indifference also contribute to inefficient management of NRs. Thirdly, the costs of resource exhaustion are felt by the future generation, whereas the benefits are enjoyed by the present. This is a form of externality, and does not figure in the decisions of the present generation to exploit the resource. Similarly, pollution resulting from misuse of resources, also do not affect the decisions regarding resource exploitation.

Local Level Management : The ill-effects of NR depletion is felt more at the locally affected sites, then by the managers who live far away in cities. Hence the local interest and responsibility

to manage resources, is much higher and if local sites are left to the surrounding population to manage, then the response and effects of resource conservation is much more efficient. Especially in the case of RRs, local communities who have felt the adverse impact of deforestation, depletion of fish stocks, of biodiversity, soil erosion etc., are best suited to manage their immediate environments. For e.g., in India, in the Nilgiris, the local tribals have made a list of plant and animal species, and conservation efforts are also taken up by them. Similarly in Bihar and Orissa, local villages and tribals have taken up protection of forests, and greening of their environments.

National Level Management : National governments also have become increasingly aware of the need for proper NR management. Legislation for preserving environmental quality and conservation are going to play an important role in ensuring that NRs are not exhausted.

International Level : A number of international agencies such as the UNEP, etc. have been set up to ensure that the environment is properly conserved. In 1972 and again in 1992, many countries of the world gathered together to chalk out various agenda and methods for the conservation of the environment. A number of international Agreements have emerged that call for the controlled use of various resources. These include a treaty on climatic change which calls for the industrial nations to stabilise their emission of green house gases at 1990 levels by 2000 A.D., a treaty on biodiversity conservation, Agenda 21 for achieving sustainable development, the forest treaty and the setting up of the Global Environmental Facility.

5.5. SUMMARY

The lesson dealt with both the theoretical and practical issues of Natural Resource depletion. While the Club of Rome Model forecasts the ultimate limit to growth caused by the exhaustion of the major mineral resources, the other models show that through mismanagement and economic incentives, such as profits, resources are exhausted at the individual level. The conservation of resources is best done when undertaken by the local village communities, within the broader policy objectives of the National and International agreements on resource conservation.

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5.6. CHECK YOUR PROGRESS : MODEL ANSWERS

1 Exponential growth can be explained in terms of doubling time. Given the base of the growing variable and the rate of growth, the variable doubles itself every few years. For e.g., if g=10% for iron ore, and initial amount mined was 100 tonnes, then every 7 years the amount mined will double itself. The danger of exponential growth is the rapidity with which the absolute quantity of the variable increases. Since the reserves of NRRs are finite, their growth at exponential rates, will quickly and suddenly bring them to the brink of the limits of exhaustion.

2. Most RRs are available freely in nature - no one owns rivers or forests. With open access, there is no restriction to the entry and exploitation of the resources. If the rate of exploitation exceeds the maximum sustainable yield, the species is driven down to its critical minimum size - and then to extinction. This is referred to as "the tragedy of the commons"

3. Physical indicators refer to the geological siting of reserves in the ground. The actual amount of reserves that can be mined depends on how 'economical' it is to do so. Economical indicators include the cost of extraction, the actual price of the mineral, the imputed future price and the rate of discount at which future earnings are discounted. Often the economical exhaustion of the resource is felt, before the physical indicators denote exhaustion.

5.7. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. "Infinite growth is imposible in a finite world" - Explain.
2. What is meant by the "the optimum rate of exploitation of renewable resources". When does it occur?
3. Discuss the role of the rate of discount and its importance in the determination of the optimum rate of depletion of NRRs.

II. Answer the following questions in about 20 lines each.

1. Write briefly about the types of renewable resources.
2. Briefly write about Exponential Reserve Index vs. the Static Reserve Index.
3. What is the role of Government in resource conservation.

BRAOU

Dr. Prabha Pant

UNIT-6 : HUMAN RESOURCES

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6.5. Principles for Lifestyle Changes
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6.1. OBJECTIVES

After going through this unit, you will be able to :

* list out and describe various consumer activities of the modern human beings and their impacts on natural environment,
* describe the principles for life-style changes.

6.2. INTRODUCTION

A look at the history of human evolution and adaptation shows that for a long period of time human activities are predominantly determined by the influence of the surrounding environment. Hence there was a high degree of variance in human lifestyles across the globe and even within the different regions of a nation. But with the emergence of modern technology, values and lifestyles, there is a gradual move towards evolution of a consumeristic culture that has international scope and range. Interestingly now instead of environment dictating human lifestyles we are in a situation where human lifestyles are dictating terms to environment. But today it is increasingly being realized that this modern cultural patterns have enormous adverse impacts on the natural environments all over the world.

A disproportionate share of the world's natural resources is claimed by the industrialized countries. It has been reaffirmed by the UN Conference on Environment and Development in Rio'92 that the world's carrying capacity cannot sustain current Western developmental patterns. Agenda.21, the action plan for sustainable development in the 21st century, states that: "the major cause of the continued deterioration of the global environment is the unsustainable patterns of consumption and production, particularly in industrialized countries. Environmental policies and national and international regulations have largely been directed towards the supply side of the economy. But the consumer, at the end of the production-consumption chain, is also crucial in achieving more sustainable patterns of consumption. Fundamental changes in consumption patterns are needed to achieve more sustainable development patterns. In today's market economy the consumer preferences are highly regarded and given preference by the producers. Any change in consumption pattern will go a long way in changing the production practices itself. But a highly informed and conscientised consumer is a prerequisite for such fundamental changes in the consumption patterns".

Changes in technology and consumer products will play a substantial role in achieving environmental quality objectives established for consumer. It is important to understand the interaction between technology/product changes and lifestyle changes.

6.3. QUALITY OF LIFE

The central concern for all development and change is improvement in the quality of life. But, quality of life is a subjective concept, dependent on economic climate and prevailing cultural perspectives and values. It depends on a number of factors essential to a good life, namely assured access to clean water, food and medical care, personal security, adequate shelter and freedom from political or legal oppression. For many of the developing countries, the challenge of sustainable development is different from that facing more modern economies, but no less urgent. They face the need to provide for basic human necessities, stabilize populations, and stimulate the economic development that can alleviate poverty, all while conserving natural resources essential to economic growth. These countries are with the lowest levels of education, the poorest health, the least access to safe water and sanitation, and the most impoverished natural resource base.

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Almost half of the aggregate population of the low- income countries is illiterate and in some of these countries three quarters or more of the people are unable to read and write. The low income countries have an average life expectance of 62 years (55 if China and India are excluded); high income countries have average life expectancies of 76 or more years. The infant mortality rate is 70 deaths per 1,000 live births compared with 8 deaths per 1,000 live births for the developed countries. Hence in these developing countries improving human health and educational opportunities are important, which also play a critical role in achieving economic development and protecting the environment. Any progress achieved by these countries on the parameters of the human development index is an indication of the degree of quality of life of their population. Efforts to develop the human resources for moving towards sustainable lifestyles can be directed only when these populations achieve certain basic requirements.

In contrast, consumers in high-input and high-output economies make heavy demands on the environment, locally, regionally and globally and that the price of high standards of material comfort and prosperity is environmental degradation. However, degradation is not yet apparent to the general public in quality or quantity terms that makes people feel that action on their own behalf is now imperative. Unlike the developing countries the people of these countries, due to a standard quality of life achieved by them, have the necessary levels of awareness that is prerequisite for developing their human resource potentials in the direction of sustainable lifestyles.

In general, consumers have an important role to play in the achievement of an environmentally sustainable society. However, for the great majority of people who live in an urban environment, the issues of soil contamination, water depletion, habitat loss are not of immediate concern, if at all they recognize and understand them. Even urban air pollution, which has visibly worsened in recent years, has not persuaded people living in its midst in anyway to reduce their energy consumption or use of personal vehicles.

Personal transport is a major contributor to global warming, acidification, high levels of noise, and sometimes odor in built up areas. In Netherlands, private cars account for some 88 percent of vehicles on the road. Inspite of the greater fuel efficiency and emission controls in motor cars, energy consumption and levels of polluting emissions (excluding lead) associated with vehicle use have also risen. That is, with technology though automobile efficiency has helped in decreasing emissions per each automobile, the increasing number of automobiles is wiping out this advantage.

On the other hand. consumption of consumer goods has risen sharply in the last two to three decades, reflecting greater prosperity and the wide availability of a new range of technological, household, personal and recreational products. Advertising and rapidly changing fashions have also strengthened the tendency to replace products more often than earlier and to package them more elaborately. As a result, household waste now accounts for approximately 14 percent of all waste going to landfill; per capita volumes of household waste have risen steadily since the 1970s. In addition, many household products, cleaning materials and toiletries contain harmful or potentially harmful chemicals which through use or disposal, contribute to contamination of soil, air and water.

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High consumption of meat and dairy products encourages livestock farming which contributes to a number of environmental effects. Livestock farming as a major consumer of energy (feedstocks and machinery) is source of carbon dioxide emissions; animals themselves are a source of another greenhouse gas - methane. In addition, livestock farming generates some 15 million tonnes of manure each year, creating severe problems of acidification and waste disposal. But this is a problem exclusive to the developed countries.

Consumption of all intensively raised foods contributes indirectly to the problems of eutrophication and diffusion, caused by high use of fertilizers and chemical pesticides. In most of the countries, wherein substantial proportion of land is devoted to agricultural activity, it is the conventional agricultural practices which is responsible for between 70 to 80 percent of eutrophication. This trend cannot be reversed by the efforts of a single nation because today agricultural goods are traded internationally and hence consumers at global level need to make concerted efforts.

Check Your Progress - 1, 2 & 3

1. Recall the difference between the developed and developing countries average life expertancy.

2. What is the appropriate percentage of global waste that is going for land till.

3. Write any one environmental effect of highly consumption of meat and other products.

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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6.4. CONSUMER ACTIVITIES

Every consumer activity involves an environmental impact of some kind, whether directly or indirectly via the operations of producers and suppliers. However, four key areas have been identified where consumer lifestyles make a clear and sometimes major contribution to environmental damage.

Consumer activities can be grouped under four principal categories :

* in the home and at work
* travel and transport
* leisure and recreation
* purchasing products and services

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Purchasing goods and services is fundamental to these areas of activity. Almost every activity involves a purchasing decision of some kind. To a considerable extent, the achievement of sustainable and high quality lifestyles will depend on the development of more efficient and less environmentally damaging products and their acceptance by consumers. In the following we will discuss consumer lifestyles by linking them with each of the environmental themes like wastage, climatic change, acidification, eutrophication, diffusion, waste disposal, disturbance and dehydration. Some of the activities mentioned here pertain exclusively to highly developed countries, and to highly sophisticated cities of the world even in developing countries. But they indicate a trend, which is being followed by increasing number of people, according to their prevailing situations.

6.4.1. Consumers and Wastage

Wastage is a given priority because it is fundamental to all other themes; it is concerned with the efficient use of materials and energy and with the sustainable management of natural resources. Wastage is a first order effect of unsustainable consumer lifestyles. This is not in itself an environmental impact but it is a form of activity that has following outcomes :

* depletion of fossil fuels (energy inefficiencies);
* depletion of non-renewable resources (minerals);
* unsustainable rates of consumption of renewable resources (eg timber);
* degradation of other natural resources (eg fresh water, fertile soil, attractive landscapes and natural habitats).

Activities, at home and at work, like heating or cooling, lighting, personal hygiene, washing, eating or drinking, cooking, preparing food, cleaning, using recreational goods like TV, Tape recorder and other electronic equipment, decoration and discarding of various wastes, are increasingly becoming high energy and material consuming ones. Given the changes in lifestyles, there are lot of wastage involved in these activities. Similarly activities like travel and transportation for reaching the work place, shopping, escorting children, visiting friends and family, taking holidays, trips and excursions and access to entertainment/leisure etc.. also is involves a high degree of wastage. All such wastage are contributing to various environmental impacts.

6.4.2. Consumers and Climatic Change

Human activity is increasing the concentration of natural greenhouse gases in the atmosphere to the point where they are interfering with the earth's heat radiation. The key factors in global warming with the consumers in context include the following :

* burning of the fossil fuels by various human activities contribute directly to the greenhouse effect. Households are becoming important sources of carbon dioxide emissions. In fact globally the households and the vehicle emissions together exceed those from power stations.

* deforestation, mainly in the tropics releases gases through burning and removal of trees which soak up atmospheric carbon dioxide.

* agriculture, especially the livestock account for about half of human activity-related methane emissions and chemical fertilizers cause a large part of nitrogen dioxide emissions.

The principal causes of ozone depletion were the use of aerosols, solvents and foams and refrigeration/ air conditioning. Consumer products and consumer related traffic/transport and buildings account for most of the ozone depleting substances.

Trends in consumer behavior show that globally the energy consumption, in all forms, are on the rise for the last three decades. Even in agriculture and its allied sectors the energy inputs are on the rise, especially in the form of electricity and fossil fuels.

6.4.3. Consumers and Acidification

Atmospheric pollutants at high concentrations can cause direct contact harm to animals, plants and masonry; acid substances are also precipitated in rainfall where they accumulate in surface water, soils and on buildings. Some key causes of acidification are the following :

* industrial pollution, caused by industries producing consumer goods, and plastics.

* traffic where vehicle exhaust emissions are a major contributor of sulfur dioxide and by far the largest source of oxides of nitrogen and volatile organic substances (VOC).

* consumers, who contribute directly to oxides of nitrogen and VOC emissions through heating their homes and driving their cars; to nitrogen trioxide emissions through the use of a variety of household cleaning products; and, to VOC emissions through the use of solvent-containing products such as paints and adhesives. Indirectly, consumers also contribute to the emissions of power stations and refineries (through their consumption of gas, electricity and liquid fuels) and to ammonia emissions (through their consumption of meat and dairy products).

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6.4.4. Consumers and Eutrophication

Eutrophication involves the disturbance of ecosystems in or near surface waters and contamination of ground water reserves, caused by excessive concentrations of nutrients. Conventional agricultural practices with high application of chemical fertilizers and pesticides lead to loading of water ecosystems with phosphorous and nitrogen and waste water and sewage which are significant sources of nitrate pollution through human faeces and food waste. Sewage is a big problem produced by modern cities and towns, and released irresponsibly into natural water courses and lakes, causing eutrophication, and the death of the water systems. This has a far reaching impact on the local hydrology and ultimately the meteorological conditions.

6.4.5. Consumers and Diffusion

Diffusion involves the spread and accumulation of manufactured chemicals in the environment. Between 60,000 to 1,00,000 chemicals are used commercially in the production of goods and services, of which many are known to be toxic or hazardous at certain concentrations.

To elaborate, a vast number of chemicals are in use whose long term effects in the environment are partly or wholly unknown. It is not possible to quantify the degree of risk associated with all products and processes or to calculate the degree of responsibility of different sectors in society. However, consumers represent the end use of many economic functions and play a highly significant role in diffusion. Many of the common household products like soft furnishing materials, tools, toys and appliances, synthetic fibres and plastic used in clothing, carry bags and footwear, toiletries and cosmetics, health care, medicines and products, hygiene and cleaning services like laundry, dry cleaning, polishes, disinfectants, etc., are known to cause actual or potential diffusion of chemicals in the environment.

BRAOU

6.4.6. Consumers and Waste Disposal

In the developed countries, approximately one ton per person per year of solid waste is generated and most of the developing countries are also following their footsteps in generating waste. Globally, the household waste volumes have been rising steadily since the 1970s, largely as a result of greater consumer affluence (more products) and greater quantities of packaging used for all products and especially for food and drink.

Principle generators of solid waste are industry, agriculture, construction and demolition industry, sewage sludge, households and chemical waste. Disposing these tonnes and tonnes of waste has become a major problem in cities like Tokyo and most of the other cities across the world. There is now a demand for land to fill with these waste. Consequent to stringent environmental laws and asserting of rights by the people to allow landfills in the neighborhood, developed countries are looking for lands in the developing countries. Earlier widespread disposal into the sea and oceans has been banned across the world, but it is something which cannot be monitored rigorously. Thus most of the household waste and other forms of waste is ending up in the oceans, causing immense damage to the marine environment.

6.4.7. Consumers and Disturbance

The problems of noise and odor are to some extent subjective, and the degree of nuisance experienced depends not only upon intensity of sound or odor but on the duration and circumstances of exposure.

Road traffic is by far the most important source of noise pollution. Air traffic, industry and rail traffic cause serious noise nuisance to a smaller number of households. There is also perception that 'neighborhood noise' has worsened in recent years. Increased ownership of electric appliances (washing machines, vacuum cleaners, power tools), electronic goods (televisions, stereos, portable radios), amplified entertainments (discos, funfairs, sporting events with PA systems), background music (shops, hotels, restaurants) as well as increased infrastructural noise (construction, transport and industry) have contributed to a significant increase in the overall level of noise in the society.

Consumers contribute to the increase in odor problems through their contribution to mounting waste piles.

6.4.8. Consumers and Water Scarcity

There are various strategic threats to the global water system and are briefly underlined as following :

1. The first strategic threat is a redistribution of fresh water supplies as a result of global warming.

2. The second strategic threat and perhaps the most widely recognized is the rise in sea levels and loss of low-lying coastal areas around the world.

3. The third strategic threat to the earth's water system involves massive changes in land use patterns, especially widespread deforestation. The destruction of forest can affect the hydrological cycle (the natural water system) in a given area.

4. The chemical pollutants produced by industrial civilization is contaminating the worldwide water resources and

5. Rapid growth in urban population, especially in the Third World, represents the fifth strategic threat to the global water systems. Per capita urban usage of water is more than in the rural areas due to the artificial environment in the cities, and also due to the consumer goods and lifestyles.

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Consumer trends show that the consumption of water has been dramatically rising all over the world since 1960. The demand is continuously rising on an average at the rate of 1.5 to 2 percent per year. This increase is mainly due to many households being fitted with showers, bath tubs, to the growing number of domestic appliances which achieve labor saving at the cost of lower water efficiency and possibly to a greater emphasis on washing and cleaning homes and, especially cars.

The above analysis indicated that consumers in the Western high-input-high-output economies make heavy demands on the environment, locally, regionally and globally and that the price of high standards of material comforts and prosperity is environmental degradation. Similar trends can be seen even in the developing world. Consumers have an important role to play in the achievement of an environmentally sustainable society.

Check Your Progress - 4, 5 & 6

4. Name any one principal category under which the consumer activities can be grouped.

5. How many chemicals approximately are used commercially in the production of goods & services?

6. . Write a strategic threat to global water system.

Note : (a) Write your answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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6.5. PRINCIPLES FOR LIFESTYLE CHANGES

Environment damage does not have the same mobilizing effect as, for example, a time of natural emergency such as war. While the threat of environmental damage is as great as that of war, it is not perceived that way by the majority of people. If they are to serve as realistic frameworks for the policy makers, proposed lifestyle changes should be :

* achievable without undue recourse to regulation and penalties;
* acceptable without the need for full public understanding of environmental technologies;
* attractive with no perceived decline in the standards of living.

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There are some principles which serve as the inspiration for all 'source oriented' changes in consumer behavior. The principles are :

6.5.1. Rationalize Access

In many cases it should be possible to reduce access and transportation journeys, for example, by bulk deliveries of goods to consumers in their homes. In other cases, the need for access can be removed altogether, for example, people working from home do not need to commute. It is now being conceived that with improvement in computer technology and remote communications, which enable teleconferencing and numerous other facilities, transportation can be reduced substantially, and that much of energy can be saved. Even otherwise, increasingly, governments are encouraging the usage of mass transport to reduce personalized transport.

6.5.2. Act Communally

Though a long term trend towards greater privacy and individual ownership has increased but some communal activities remain socially acceptable - traveling by public transport, dining out, drinking, and visiting cinemas. The social acceptability of acting communally could be built upon to increase the frequencies and extent of such activities in order to increase efficiency of materials and energy consumption.

6.5.3. Circulate Goods

There is a great potential for reducing resource waste through the establishment of product repair and exchange services to keep goods in circulation. Consumers need not be exhorted to consume less, if they can reuse the same product. Reuse and recycling of goods and materials is now attracting major attention in the developed countries. However, developing countries have established networks of re-usage of resources, especially newspapers, albeit due to poverty and resource constraints.

6.5.4. Buy Services Not Products

Using a publicly or privately provided service, rather than purchasing the product/appliance that performs the same function will reduce the requirement for individual products. Examples include commuting by public transport rather than driving a private car, using a laundry service rather than buying a washing machine, employing a decorating firm rather than buying do-it-yourself equipment.

These principles are applicable to many areas of life and offer the possibility of reducing environmental damage while maintaining (or improving) the quality of service and lifestyle that people currently enjoy. However, environmental sustainability is likely to demand more than an improvement in energy and materials efficiency. It demands a realistic change in the way we perceive things, in the way we relate to the surrounding environment, the way in which we mold our life goals and the way we go about achieving these goals. The very philosophical foundation on which humanity is operating has to be transformed so as to make this world as pleasurable to live as it was some hundreds of years ago. Thus value system on which we are operating need to be altered to make it more compassionate to all the species along with the fellow human beings. Hence the fundamental premise of our ethical system which has become fundamentally erroneous should be changed. This cannot be achieved just by changing the syllabus in educational institutions nor by the campaigns sponsored by government and industry. It requires changes in collective humanity - change in its thinking patterns and in its actions. The following aspects need to be considered in changing the human resource so as to make them palatable with the environmental ethics.

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* Spiritualism has to be brought back into the realm of education as well as into our day to day operations.

* Ethical lifestyles need to be emphasized in both primary as well as secondary acculturation processes.

* In place of consumeristic lifestyles, prudence and simplicity of living patterns as emphasized by Gandhiji need to inculcated since childhood.

* Greater emphasis on community participation and collective efforts to solve local problems need to be stressed.

* Environmental ethics have to be evolved as a guiding principle in all spheres of human activity.

* Diversity which has been the hallmark of human as well as organic evolution needs to be valued and cherished.

* A biocentric philosophical foundation has to replace the anthropocentrisism and the egocentric value system.

6.6. SUMMARY

In this lesson we have seen that industrial revolution has altered our lifestyle to such an extent that it resulted in creating an environmental crisis of magnitude that is beyond our imagination. It has become an imperative to change the production processes as well as the consumers life styles. These changes in the lifestyles cannot always be involuntary. Consumers need to consciously change their preferences so that it can stimulate changes in the production processes as well. We have seen in the ways in which consumer behavior effects the environment not only locally but also globally. We have also listed the possible options of changing the consumer patterns in order to make them more palatable to the environment. We noted that the change cannot be limited and piecemeal instead it should be holistic to the extent that our value system and our philosophical foundations need to be transformed. Only then we can presume that the human resources have been changed to suit the environment.

6.7. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The differance between the developed and the developing countries in terms of the average life expectancy is that in the developing countries it is 62 years and in the developed countries it is 76 or more years.
2. Approximately 14 percent of the global waste is going for the landfill.
3. Increases carbodioxide and methane emissions.
4. In the home and at work.
5. Globally between 6,000 to 10,000 chemicals are being used today for the production of goods and services.
6. Global warming.

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6.8. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Focus on the differences in the quality of lifestyles in the developing and developed worlds.
2. Discuss briefly the links between the consumers and various environmental problems with referance to the developed countries.
3. What are the principles for changing the lifestyles?
4. How should we strive to make human resources palatable with the environmental ethics?

II. Answer the following questions in about 10 lines each.

1. Which is the important source noise pollution and what are the sources?
2. How do consumers affect global warming and in what pathways?
3. What are the consumer products which use chemicals and can be harmful to environment?
4. List out the principle generators of soild waste?

Mr. K. Thilotham Reddy

UNIT -7 : TECHNOLOGICAL IMPERATIVES

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7.1. OBJECTIVES

After going through this unit, you will be able to :

* describe the role played by modern technology in disturbing the natural environment,
* discuss about the limitations of technological solutions to the problems created by modern technology,
* describe the prevailing technological scenario in developing countries,
* discuss the technological imperative with a socio-economic dimension,
* describe the role played by technology and the necessity to re-orient its priorities.

7.2. INTRODUCTION

In the unit titled "Choice of Technology " the students have already been introduced to the meaning of technology and the history of technological development. It can be recalled that modern technology has its growth predominantly in the Western world. This technology was unfriendly to the socio-economic requirements of the developing countries but also to the global environment. Over a period of time, this technology has been replicated whereby it rapidly replaced the prevailing technologies of these regions. Traditional technologies of these regions have been neglected, abandoned and forgotten. Only in recent years, with the growing realization that modern technology is ridden with unsurmountable negative consequences, scholarly attention is getting

directed towards finding technological solutions to the emerging problems along with a search for traditional technologies to revive and alternative technologies to establish. In the earlier lesson, we have learned about the efforts to revive traditional technologies and to innovate alternative technologies.

7.3. ENVIRONMENT & TECHNOLOGY INTERFACE

It is known that environment is complex both in terms of its great diversity of components and the interrelationships among those components. These components are not isolated from one another, instead, are strongly interdependent. The linkages that exist among components of the environment are the avenues along which energy and materials are transported. Those linkages among components of the environment are neither arbitrary nor capricious acts of nature, but rather, are considered to be systematic because they can be described in terms of logical principles.

For a long period of time the above said linkages of the environment have been respected and given due regard by human beings in all their pursuits including the economic activities. Hence the energy and material balances of the environment were never unduly disturbed by human activities. Therefore the human life styles of those periods were considered as sustainable with an emphasis on sustenance. Unfortunately, the modern outlook with its reductionist orientations, hedonistic values and violence ridden approach towards nature and its components has been responsible for evolving technologies that have least regard for the linkages between these components of nature. Hence these technologies started disturbing the inbuilt balancing mechanisms of the nature. These technologies entailed high risks, including new forms of pollution and the introduction to the planet of new variations of life forms that could change evolutionary paths. It is the fragmented, piecemeal and short term perspective that guided the evolution of these modern technologies. But the results that they have brought in have received all round appreciation. The countries which possessed these technologies were getting regarded as modern, progressive and developed and the rest of the world started making conscious efforts to follow the foot steps of the former countries by either importing or implanting these technologies. The industries most heavily reliant on environmental resources and most heavily polluting are growing most rapidly in the developing world. Thus, by the middle of this century, almost whole of this planet Earth started experiencing the impacts of the modern technologies. For instance, the industrial production has grown more than fiftyfold over the past century, four-fifths of this since 1950.

An important aspect of our currently advanced technologies is that they are highly complex both in technological and organizational terms. This interdependence of the sophisticated organizational and technical systems can be difficult to cope up with in case of any accident in operation of these technologies. In fact, experience has shown that there is a high degree of chance for human error or lapse in manning these modern technologies because the manpower gradually becomes mechanistic in operating these technologies.

An unfortunate consequence of replication of these technologies is that it has resulted in homogenization of the technologies all over the globe. Thus paving way for homogenization of culture and lifestyles on the patterns of the dominant Western model. But it should be noted here that an hallmark of continuous human adaptation and/or evolution is its diversity. It is this diversity which produced varied cultures and philosophical thoughts that have entrenched roots in their regions. Due to the process of homogenization unleashed by modern technology the diverse human cultures and the traditional knowledge and wisdom that accompanied them are in the process of extinction. What humanity has acquired for a long period of time is being frittered away

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in a very short span of time. But this homogenization did help a section of the society. It facilitates the market operation and the people who have stakes in such operations. It means that it serves the interests of the international corporations and the people who are manning them. To illustrate this point the example of consumer industry is very ideal. Today in any part of the globe, whether it is America or Africa, presence of multinational soft drink companies like Coke and Pepsi can be taken for granted. There are many innumerable invisible interests which strengthen and support this process of homogenization.

It cannot be absolutely said that modern technologies have only resulted in negative consequences. In fact if we take into consideration the human wants, needs and comforts, no other civilization with all its technological base could satisfy them to the extent and the manner in which our modern civilization did. It is the modern technology which has been able to satisfy the needs and wants of large sections of global population and the comforts and luxuries of a few people. It is also due to modern technologies that made it possible for human beings to communicate and interact across the globe within a matter of seconds thereby opening the chances for the formation of a global village and global governance. The vistas of human knowledge have expanded in all spheres due to the progress achieved by modern technologies. For example, today's technology made it possible for us to understand the ecological conditions on planet Mars and opened the remote possibility of human colonization of that planet. Similarly pursuit of knowledge, practice, art, architecture, medicine and culture by large sections of human population is enabled by the growth of modern technology that has generated vast amounts of leisure.

Modern technologies have also facilitated human lifestyles in manners unimagined during the pre-modern days. But at the same time it can be noticed that these technologies have brought unlimited damage to the living and non-living environment. The problems brought by these technologies include water, air and land pollution; depletion and degradation of both renewable and non-renewable natural resources; depletion of biodiversity and endangering of many living species. However, from an anthropocentric point of view, in the long run, modern technologies do not have the necessary potential to sustain human lives and meet the basic requirements of all the sections of population. If we were to take biocentric view then most of these technologies have to be out rightly discarded with immediate effect.

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Check Your Progress - 1

What are the problems brought by modern technologies?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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7.3.1. Water Pollution and Technological Solution

In response to rapid industrialization and urbanization that resulted with the introduction of modern technologies we allowed our cities and industries to foul many aquatic habitats. The sewage, garbage and various industrial effluents have gravely damaged the aquatic ecosystems. While the biological pollution of water is mainly due to the sewage and the garbage dumping into the water bodies, the chemical contamination is due to discharging of industrial effluents in various types of aquatic ecosystems. It is not only the surface water that is getting polluted by these sources of pollution but also the ground water.

Earlier biological pollution was the single largest culprit for prevalence of water-borne diseases. In the developed countries the problem of biological contamination has been more or less addressed by the first half of this century. But the chemical pollution continues to increase on an accelerated pace even to this day. The water resources in these countries are assaulted by such chemicals as commercial fertilizers, pesticides, detergents, trace metals, radio active substances and other wide variety of industrial chemicals. Unfortunately, even in the developing countries both the biological and chemical pollutions are on the rise.

With the above said kinds of sources of pollution the potentials for the food being contaminated by carcinogens (cancer causing compounds or elements) as a result of water pollution are very high. These pollutants have been disrupting aquatic ecosystems by interrupting the life cycle of certain organisms that are dependent on these ecosystems. As the technology became advanced or more sophisticated, the types of wastes that are discharged into water ways became even more varied and dangerous. Various studies have shown the impact of bio-accumulation of toxic substances due to water pollution. Mercury poisoning of hundreds of people in Minamata, Japan, dramatically illustrated accumulation of toxic substances in the food web and its effects on human central nervous system. Apart from Mercury, heavy metals like Arsenic, Cadmium, Nickel, Chromium etc are not only just hazardous but also carcinogens as well. Thermal pollution, pollution by organic chemicals like PCBs (polychlorinated biphenyls) and dioxin, and radio active substances are other types of pollutants that are affecting aquatic ecosystems. All these pollutants are by-products of our modern technologies and the lifestyles that they have generated.

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In order to reduce the water pollution, various technologies have been developed and are in the process of development. These technological advances have been able to curtail the biological pollution of water to a large extent in the countries that have good financial resources. But the problem of chemical pollution of water is not addressed totally even in the advanced countries in spite of developing various kinds of effluent treatment technologies and machinery. Most of these technologies do leave certain residual levels of contaminants in the discharge water. To further reduce the residual contaminant levels in some cases, the technology itself is not available and even if it is available it involves employment of costly procedures. Usually it costs as much to remove approximately the last 10% of the residual pollutants as it does to remove the first 90%. Industries in the West are hindered by the limitation imposed by the exorbitant treatment costs, and has some effect on the industrial growth being shackled by the strict environmental legislations. For some wastes and effluents, non availability of the technologies is a further hindrance. If we consider the case of developing countries the technological solutions that are available to address the biological pollution itself is not being deployed thereby we are witnessing an epidemic creating havoc every now and then in our cities (like the Plague and Dengue in Surat and Delhi respectively). Either due to resource constraint or due to lopsided priorities of the policy makers of these countries, water borne diseases are still rampant in most of the regions. Many of the highly populated cities of

these countries do not have the treatment plants for drinking water and the sewage. Being plagued by such age-old problems, facing the challenge of installing efficient effluent treatment plants for all types of industrial discharges to tackle the problem of chemical pollution of water is a tall order for most of these resource starved countries.

7.3.2. Air Pollution and Technological Solution

The industrial revolution was the single greatest cause of chronic air pollution in Europe and North America for more than one century and for last half a century for the rest of the Earth. In fact, for many years a Western city took pride in its smokestacks which were considered to be a sign of a prosperous economy. Air pollutants are airborne gases and aerosols that occur in concentrations that threaten the well-being of living organisms or disrupt the orderly functioning of the environment. Important sources of atmospheric pollutants include motor vehicles, chemical plants, thermal power stations, oil refineries, smelters pulp and paper mills, iron and steel mills, etc. Apart from these industrial and domestic furnaces, burning of refuse also contributes to air pollution.

Principal air pollutants in this industrial age are oxides of carbon, hydro carbons, oxides of nitrogen oxides of sulphur etc.

(1) **Oxides of carbon :** Carbon monoxide causes drowsiness, slows down reflexes, impairs judgement and at high concentrations death. Carbon dioxide levels are increasing at a rate of approximately 20 ppm every decade and this may eventually lead to global warming through greenhouse effect.

(2) **Hydrocarbons :** Methane, terpenes, benzene, benzpyrene etc can be hazardous when present in high concentrations. Benzene and benzpyrene are carcinogenic and rest of the hydrocarbons create most serious health effects after reacting with other pollutants in the presence of sunlight. They can damage eyesight and the respiratory system.

(3) **Oxides of Nitrogen :** Nitric oxide and Nitrogen dioxide are two types of oxides of nitrogen which pollute the atmosphere. Of these two, nitrogen dioxide is approximately four times more toxic than nitrogen oxide and it is a much more serious air pollutant; nitrogen dioxide at high levels can contribute to heart, lung, liver and kidney damage and it is even linked with bronchitis and pneumonia.

(4) **Components of sulphur :** Various compounds of sulphur that are generated by human activities like sulphur dioxide, sulphur trioxide, sulphur particles, sulphuric acid and hydrogen sulphide etc pose several health hazards like irritating respiratory passages and by aggravating such conditions as asthma, emphysema and bronchitis.

Photochemical smog and suspended particulates are the other significant sources of outdoor pollution. Apart from these, the increasing levels of noise pollution, in the modern age due to various human activities, is causing hearing loss. The modern lifestyles have been responsible for polluting not only outdoor air but also indoors. Radon, Formaldehyde, Aerosols, Ammonia, Synthetic fibres, Asbestos etc are major indoor pollutants that create various types of health problems.

The impact of these air pollutants on human and animal health is well recorded. There are studies which have documented their impact on vegetation as well. We have already learned about the threat to ozone shield and the prospects of global warming.

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The modern technology developed upon by the consumeristic values disregards the linkages between various components of environment and hence its approach to solve the problems arising out of this situation are also short sighted and segmentary. A look at the technological approach to control air pollution gives clear picture of the existing scenario.

Technologies have been evolved to remove particulates from industrial stack emissions. These are electrostatic precipitation, filtering and gravitational settling. Similarly to reduce sulphur dioxide emissions technologies like scrubbing, physical coal cleaning, fluidized bed combustion coal liquefication and coal gasification are being evolved. To control pollution of oxides of nitrogen staged combustion technology is being proposed. There have been technological efforts to control motor vehicle emissions. For example, use of the positive crankcase ventilation, and catalytic converters are few such efforts. Though these technologies have been able to reduce or control air pollution levels to an extent, many difficulties remain. A clear indication of this problem is the increasing levels of pollution with each passing day.

An important aspect of any of the pollution control technologies is that it involves high capital investment and hence the industries that developed existing technology and the ones which have bought them, due to involvement of their interests, show commitment to the existing technological systems. Thus it acts as a limitation for the flexibility that may be necessary to adapt to safety requirements. Let us take the example of common effluent treatment plant operating in any industrial area. Most often these plants are owned by private persons who invest their capital in the plant. Suppose either because of the incoming effluents have become complex or because of emergence of advanced treatment technologies, the existing technology might become less effective. But against their private interests these individuals will never admit their limitation, instead they will extend their support to the existing technology.

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In case of developing countries the problem is even bigger in proportions. In order to catch up with the developed world, technologies are being imported which were discarded in the West as highly polluting their countries. Due to limitations in the technologies and the costs involved, most Third World Countries are becoming dumping grounds for the hazardous and highly polluting technologies. Absolutely nil efforts are being made in these countries to develop alternate technologies or the pollution control technologies. A great deal of money is required for research and development of these technologies and the industries have to spend enormous amounts on the purchase and maintenance of these devices. It will be a large investment for the developing countries even to import the environmentally sound technologies leave alone developing them. The rough estimations projected at the Earth Summit in 1992 shows that at least finances to the tune of $550- $700 million per year are required to promote the transfer of environmentally sound technology from the developed countries to the developing world.

Modern technologies have brought forth innumerable other environmental problems like :

(a) Reduction in forest cover leading to gradual desertification of the arid and semi arid regions of this globe. Deforestation in Latin America and Asia is causing more floods, and more destructive floods, in downhill, downstream nations.

(b) Depletion of non-renewable resources and degradation of renewable natural resources.

(c) Accelerated reduction of soil fertility and endangering availability of food for growing millions of people.

(d) Acid precipitation and nuclear fallout which have spread across the borders of Europe initially are on a global scale today.

e) Internationally traded hazardous chemicals entering foods are themselves internationally traded.

(f) Enhancing unsustainable consumeristic aspirations and expectations of larger sections of population with limited capabilities to solve them.

(g) Ever increasing disparities among regions as well as people.

Check Your Progress - 2 & 3

2. Write few examples of hydrocarbons which are lethal to humans?

3. What are the compounds of sulphur which pose several health hazards?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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7.3.3. Promises and Risks of New Technologies

With careful management, new and emerging technologies offer enormous opportunities for raising productivity and living standards, for improving health, and for conserving the natural resource base. For example, information technology based chiefly on advances in micro-electronics and computer science is of particular importance. It can help improve the productivity, energy and resource efficiency, and organizational structure of industry.

New materials such as fine ceramics, rare metals and high performance plastics, new composites allow more flexible approaches to production. They can contribute to energy and resource conservation.

Biotechnology will have major implications for the environment. Its products can improve human and animal health. New drugs and new therapies can be found. Energy derived from plants could increasingly substitute for non-renewable fuels. It has the potentials to revolutionize the agricultural sector. It could also yield cleaner and more efficient alternatives to many wasteful processes and polluting products. New waste disposal techniques are promising through this biotechnology.

Advances in space technology can help in making good planning for farmers. Remote sensing facilities can make optimal use of the Earth's resources. It can help in monitoring and control of soil, water and air pollution.

Yet new technologies are not all intrinsically benign, they can lead to unknown dangers. Hence we need to be cautious even in introducing these technologies.

7.4. GLOBAL IMPERATIVES

7.4.1. Technological Imperative for Scientists and Technocrats

It is the need of the hour to consciously divert the scientific and technological manpower's attention towards evolving the technologies that are environmentally friendly. Environmentally sound technology, in general refers to production methods that are less polluting than used methods, consume less energy and fewer resources and recycle waste or handle them more acceptably. Some examples are: (a) Heat controls and insulated pipes that make energy plants more efficient (b) Processes to remove pollutants from raw materials before production, or (generally more expensive) to remove wastes before they are discharged (c) Cooling agents that do not use ozone-depleting chlorofloro carbons.

In order to evolve such an environmentally friendly technology the scientists should adopt systemic or wholistic perspective wherein the linkages between various components of environment are respected and the energy and material balances of the environment are given their due regard. Secondly, the long term impacts of technologies on the environment should be closely studied so that in the long run technologies do not lead to unsolvable environmental problems. For example, when plastic and polythene was invented it was hailed all over the world but today its widespread manufacture and usage is leading to non-degradable dumps all around the earth whereby hindering the vegetation growth in those places. Similarly the invention of hydrocarbons was well acclaimed but today their widespread usage is paving way for ozone shield depletion creating alarming prospects for the future of all living organisms on earth. Emphasizing this point Agenda 21 of the Earth Summit says that " sustainable development requires taking a long term view based on the scientific knowledge available, being prepared for surprises and linking knowledge to global policy. Science, applied to policy and planning, can provide a path towards sustainable development". Hence it is imperative for technologists to imbibe environmental ethics before embarking on the mission of developing new technologists.

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7.4.2. Imperatives for Industry

1) It should play a major role in reducing impacts on resource use and the environment through efficient production processes, preventive strategies and cleaner technologies and procedures.

2) It should work with governments to identify and implement an appropriate mix of economic instruments and normative measures such as laws, legislation and standards to promote use of cleaner technologies.

3) It has to integrate cleaner production approaches into the design of products management practices.

4) It should arrange environmentally sound technologies to be available in developing countries.

5) Increase research and development efforts for environmentally sound technologies and environmental management systems in collaboration with academic and scientific/engineering establishments, drawing upon indigenous knowledge,where appropriate.

6) Integrate cleaner production principles into training programmes of its personnel. Too often firms pollute not just through accident or by design but through gross ignorance by the labour involved in the destructive effect on the environment.

7) Establish cleaner production demonstration projects/ networks by sector and by country and

8) Strive to establish environmental partnership schemes with small and medium sized enterprises.

7.4.3. Imperatives for Governments

1) Should identify and implement an appropriate mix of economic instruments and normative measures like laws, legislations and regulations by means of codifying standards to promote the use of cleaner technologies.

2) Grants should be provided for academic and scientific institutions for research and development of environmentally sound technologies.

3) Incentives like recognition through awards etc should be given to good breakthroughs in environmentally sound technologies.

4) Special efforts should be made to encourage research on the indigenous knowledge systems so as to integrate them into current practices.

5) Industry and institutional interaction should be facilitated in all possible manners in order to encourage adaption of environmentally sound technologies.

6) Encourage industry to invest in promotion and/or recycling technologies and related training programmes so as to ensure environmentally sound management of hazardous wastes.

7) Launch demonstration projects and waste management campaigns on cleaner production and publicise local success stories, and

8) Harmonize the classification of chemicals and labeling systems for chemicals using all official languages and pictograms.

7.5. SCENARIO IN DEVELOPING COUNTRIES

In the above section we have focussed on modern technology through environmental dimension but there is also socioeconomic dimension to technology which cannot be ignored. In the following section we will briefly focus on technology through socio economic dimension by bringing out certain subtle nuances. Though human beings have attained enormous success in various fields of science and technology yet for large numbers of human population basic needs like food, shelter and clothing have not been met adequately. In fact as the figures show, the citizens of more than 20 nations actually receive less than 90% of the calories that they need, while the citizens of another

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30 highly populated nations receive just enough calories to meet their needs. The UN estimates show that as many as 500 million persons (approximately 1 out of every 9 persons) is suffering from malnutrition today. The situation in certain parts of Africa show the negative impact of modern technology. A lot of youth in the Third World countries and even adults are unemployed. We need simple technologies whereby one particular person can do a kind of a job that could have provided job opportunities to several hundreds.

If we look at the technological development in case of India we find glaring lapses. Our technological achievements are very laudable. We have acquired the space launching potentials, developed our own super computers, developed advanced weapons etc. But our technological efforts have not been able to help farmers, like plough, bullock cart etc more efficient. The drudgery of the rural women have not been addressed. The lopsidedness of our technological growth can be visualized by the fact that majority of people do not have basic requirements like safe drinking water and sanitation while a section of people lead life by only consuming mineral water. The technology has not been able to provide gainful employment to either educated or uneducated youth but a section of youth with access to information and investments are able to corner jobs with salaries to the tune of lakhs of rupees annually. The technology is largely catering to the requirements of the rich and the middle class urban population and hence its impact is directly visible on the lifestyles of these classes. While 30% of population are still languishing below poverty line and crying for attention, the technological manpower of India, which is considered to be the third largest in the world, is oriented towards enhancing the comforts and luxuries of a few upper strata of population. The consumeristic lifestyles of these latter category are comparable to that of those in the west. For example, while there are still many houses without an electric bulb but we have been finding technological solutions for the rich, so as to enable them escape the inconveniences of the power cuts, like UPS (uninterrupted power supply) systems and other improvisations.

7.6. REGIONAL IMPERATIVES

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The technological imperatives for the developing countries should also include those environmental imperatives that operate in the developed countries and also certain other ones. A few of such imperatives are the following :

Firstly, the technologies in these regions should be directed to solve the basic needs of all sections of population.

Secondly, the technologies should be oriented towards providing better lifestyles the rural people.

Thirdly, the technology should be directed to address the problem of unemployment among the urban and the rural poor.

Fourthly, reduce the drudgery of the women especially the rural women.

Fifthly, the technology should address gender biases in its growth and development.

Sixthly, technologies should be locale specific to suit not only the climatic conditions but also the socioeconomic landscape of the country in which it is operating.

Seventhly, the technologies should enable lifestyles which are sustainable and ecological friendly.

Eigthly, the technologies should not enhance the existing disparities in societies, instead, they should strive as much as possible to enable equitable distribution of wealth and resources.

Ninthly, the technology should enhance peoples participation hence they must be user friendly as much as possible.

Finally, it is the need of the majority that should act as a guiding principle for the growth of technology rather than the greed of the few.

7.7. CONCLUSION

In this unit we have understood that technological solutions to the human problems cannot disregard the linkages between various components of environment. Any such endeavour which disregards these linkages, however beneficial it might be in the short term but in long run proves disastrous to human and other living beings. Unfortunately this is the mistake that the modern technologies have been committing and hence the negative results are very much available for us to witness. It is imperative for the elite as well as for the general population to discard the blind faith on technology that they have developed over a period of time. Instead of presuming that technology will eventually find solutions to all the problems faced by the human population, they should strive to create a climate of opinion that alters our thinking and actions. As a result of such change, our future technologies and the lifestyles that they generate should not only be environment friendly but also friendly to the socioeconomic and cultural mooring of the region in which they operate.

7.8. SUMMARY

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Modern technology has its growth predominantly in the Western World. This technology was unfriendly to the socioeconomic requirements of the developing countries but also to the global environment. Environment is complex with its great diversity of components and the inter relationships among them.

An important aspect of our currently advanced technologies is that they are highly complex both in technological and organisational terms. An unfortunate consequence of replication of these technologies resulted in homogenization of technologies all over the globe, thus paving the way for homogenization of culture and lifestyles on the patterns of the dominant western world. Modern technologies have also facilitated human lifestyles in manners unimagined during the pre-modern days. It can also be noticed that these technologies have brought unlimited damage to the living and nonliving environment. The problems brought by these modern technologies are water, air and land pollution, degradation and depletion of renewable and non-renewable resources etc.

With careful management, new and emerging technologies offer enormous opportunities for rising productivity and living standards, for improving health and for conserving natural resource base. Biotechnology will have major implications for the environment. Its products can improve human and animal health. Advances in space technology can help in making good planning for farmers - Remote sensing facilities for farmers. Remote sensing facilities can make optimal use of the earths resources.

Though human beings have attained enormous success in various fields of science and technology yet for large numbers of human population basic needs like food, shelter and clothing have not been met adequately. If we look at the technological development in India we find glaring lapses. Out technological efforts have not been able to help the farmers. Majority of our people do not have safe drinking water and sanitation.

7.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Modern technologies have brought unlimited damage to the living and non-living environment. The problems brought by these technologies are water, air and land pollution, depletion and degradation of both renewable and non-renewable resources, depletion of biodiversity and endangering of many living species.

2. The hydrocarbons which are lethal to humans are methane, terpenes, benzene, benzpyrene etc.

3. The compounds of sulphur which pose several health hazards are sulphur dioxide, sulphur trioxide, sulphur particles, sulphur acid and hydrogen sulphide.

7.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Write briefly about environment and technology interface.
2. Write briefly about water pollution and the technological solutions for it.
3. Briefly write about air pollution and technological solutions.
4. What are the promises and risks of new technologies?

II. Answer the following questions in about 10 lines each.

1. What is the toxicity caused by heavy metals?
2. Write briefly about oxides of carbon.
3. Briefly write about hydrocarbons.
4. Write briefly about oxides of nitrogen.
5. What are the compounds of sulphur which pose health hazards to human beings.

K. Thilotham Reddy

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BLOCK - 3
CHALLENGES-I

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UNIT-8 : FORESTRY

Contents

8.1. Objectives
8.2. Introduction
8.3. Resource Base
8.4. Tribals and Forest Policy
8.5. Forest Policy
8.6. Summary
8.7. Check Your Progress : Model Answers
8.8. Model Examination Questions

8.1. OBJECTIVES

After going through this unit you will be able to :

* explain the importance of forests,
* list out the important products of plants,
* list out the reasons for soil erosion,
* describe tribals and forest policy, and
* list out the steps to be taken for protecting the forests.

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8.2. INTRODUCTION

One of the major environmental concerns of today is the fast degeneration of forests all over the world. Forests must occupy 33% of the land-mass. In Andhra Pradesh, forest area consists of 64000 sq.km or about 22% of the land area. Actually only half of it has crown-density. Effects of large scale deforestation are already felt in India, Africa and South America. Frantic conservation and regeneration programmes are being prepared. In Andhra Pradesh, part of forest management in the peripheral villages is being given to people. It is called Joint Forest Management with people's participation.

It has long been accepted that forests play a dominant role in human's survival on earth. Forests controlled regenerated themselves. Besides all this, forests are genetic pools; Rice varieties, domesticated animals, vegetables, medicinal plants & building materials are some of the most important forest products. In otherwords, bio-diversity keeps human life going in a number of known and unknown ways. They receive rains and let off water slowly into rivers and streams preventing soil erosion. Tribal communties have been living in the forests since pre-historic times. Avoidable developments like deforestation and proxy land grabbing etc have been a threat to the existence of these tribal communities. In India Chipko Movement remains a land mark in people's movement to protect forests. Experiments like in Sukhomajiri and Ralegaon Sindhi indicate, however sporadic, people's determination to manage local eco-system. It is also a realisation of the concept of common-resource-property.

8.3. RESOURCE BASE

As mentioned above, it is impossible to think of human life without forests. Almost every single thing we eat has its forest origins. Horse, Milch-cattle, dogs etc are mutated wild species. Forests are unimaginably rich in medicinal herb and plant species. If forests disappear at the rate they have been, humanity would be deprived of invaluable insurance against disease. So what has been happening was a senseless eroding of our resource base. The wants of a modern industrial society are decidedly more and diverse and hence a certain degree of exploitation is unavoidable. But what is avoidable is mismanagement on one hand and indifference to regeneration on the other. In an increasingly consumptive world, consumption and regeneration should be judicious. It is also pertinent to bear in mind that developed countries gobble up 80% of world's resources. Developing countries have to avoid activities that are potentially dangerous to the resource and detrimental to bio-diversity.

Rural communities that have been living on the forest periphery have been depending on the forest for fuel and fodder. At one time "Vanapanchayats" judiciously controlled these activities. Over a period of time over-grazing has become a threat to the forest. Lure of illegal logging encouraged tribals to become head-loaders. Obvious pressure has been from the nearest town whose needs have to be met.

Formation of an inch of top soil takes a minimum of a century. This layer receives rain, retains water and slowly releases it into rivers saving the soil fertility. Deforestation in the catchment areas leads to washing away of this precious layer. It also results in siltation of rivers which rises the water table. Thus even normal rains cause floods and sand casting of agricultural lands because the river lost its water carrying capacity. In a chain reaction, river embankments get breached and river might even change its course. These are linkages in eco-systems. Dams built at huge costs may be rendered useless, the unfortunate example being Sri Ram Sagar Project in Andhra Pradesh which has silted up beyond repair.

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Another aspect of deforestation is the role of forests as climate controllers. Subtle and not so subtle climatic changes for the worse could be noticed where large-scale deforestation had taken place, as their role as carbon-fixers is weakened. In this context we have to remember man-made forests lack bio-diversity.

8.4. TRIBALS AND FOREST POLICY

Forest dewellers have been living in the forests since times immemorial in perfect harmony with nature. Development activities have been displacing tribals. They depend on the minor forest produce which is becoming scarce. Not withstanding the good or indifferent rehabilitation programme, tribal ethos nurtured by the forest eco-riches is irretreivably lost. Tribal community life is basically different from a village community in plains.

Displacement raises the question of tribal rights. Do they not have any rights over their own habitat? Are not they forced to leave their homes for benefits they never shared in? It is now argued forcibly that tribals infact are being forced to sacrifice their livelihood so that others are benefited. There is an ethical aspect to the question. There have been instances of clever eviction of tribals by occupying their lands. This was achieved by a simple process of calculated migration of plains-men into tribal lands. If right to life and livelihood is applicable to the rest of the Indian citizens, tribals could also seek the same constitutional protection. Law provides safeguards against tribal lands being occupied by non-tribals. Benami land transactions are resorted to, in order to circumvent the law.

8.5. FOREST POLICY

The first conservator of forests has been appointed in 1806. At that time and much later the plan was only to exploit forest wealth. But now forestry is integrated planning to conserve. Strict forest laws and wild life protection laws have been enacted. New sanctuaries are being prepared. Laws have not been able to prevent either deforestation or degeneration. It may be partly owing to the lack of inter-departmental understanding. Also law has not been able to curb occupation of tribal lands by non-tribals. But as suggested above the present policy is geared to regeneration of forest by community participation.

This approach is now called Joint Forest Management (JFM). Under this plan communities, local administration and NGOs are involved. It is a welcome change. It is an important step towards preserving the Bio-diversity and providing the much needed fuel and fodder to the people. But more than that it is recognition of community-resource-property and people's ability to manage their resources. This ability was evident in Sukhomajiri (Haryana) where entire community in the village greened their village. It is now a self-sufficient village where the whole community manage their fuel, fodder and water needs.

People also showed their willingness to fight and sacrifice to protect their resources. India's most famous movement in this regard was Chipko Movement which was led by women. When timber contractor's men moved to fell the trees, women hugged the trees and dared the men to cut the trees. It only proves that common people whose livelihood is at stake would be prepared to protect their common property.

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Check Your Progress - 1 & 2

1. When was the first conservator of forest appointed? What was the purpose then?

2. Who have greened their village?

Note : a) Write the answers in the space provided below.

b) Compare your answers with those given at the end of this unit.

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8.6. SUMMARY

Forests are genetic pools which help humanbeings to meet their wants. Food, fodder, medicines and building materials have been gifts of forests. Hence they are called our resource-base. The need to protect this base for the present and future generations is obvious. Bio-diversity cannot be substituted. Loss of species of flora and fauna affects human life adversely. Deforestation and degeneration of forests should stop immediately. Deforestation leads to siltation of rivers and loss of invaluable top-soil.

Intimately connected with forest eco-system are tribals who have been living in these eco-riches since prehistoric times. These forest dwellers are being displaced from their habitat owing to deforestation and developmental projects. As they lose their livelihood a question of their right to life should also be examined. It is also an ethical issue. Tribal culture is vanishing.

Forest laws and wild life protection laws have not been able to protect either forests or wildlife. Non-tribals occupy tribal lands by various unethical methods. It is a clear exploitation. Tribal culture is generally misunderstood as inferior.

But some communities have been known to protect their common resource-property. Famous example of this movement is the Chipko Movement where women hugged trees to prevent their felling. Similarly at a place called Sukhomajiri people joined efforts to regenerate their local resources. Resources unite people.

A significant step towards forest regeneration is Joint Forest Management (JFM) which laid stress on community management of local resources. JFM involves NGOs, Administration and Forest Dept. Protection of our resource-base is ultimately the responsibility of the people. Hence the concept of common-resource-property.

8.7. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The first Conservator of Forest was appointed in the year 1806. The purpose of appointment was to exploit forest wealth.

2. The villagers of Sukhomajiri in Haryana district have greened their village which made them self sufficient for fuel and fodder.

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8.8. MODEL EXAMINATION QUESTIONS

I. Answer the following question in about 30 lines each.

1. Write briefly about resource base.
2. Write briefly about forest policy.

II. Answer the following questions in about 10 lines each.

1. Write briefly about soil erosion.
2. Briefly write about tribals and forest policy.

Dr. T.P. Sastry

UNIT - 9 : WATER RESOURCES

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9.1. OBJECTIVES

After going through this unit, you will be able to :

* describe the usage pattern of water
* describe the management of water resources
* explain the measures of conservation and protection of water resources.

9.2. INTRODUCTION

A country's development process to be successful must be total and eventually cover all areas of national life. However, in order to set priorities and allocate scarce resources, governments commonly pursue goals within specialized areas, each with its own problems and its own set of relevant policies and technologies. Traditionally, these specialized areas of development - agriculture, education, and health, for example - are called "sectors". The sector provides the organizing focus for the planning, implementation, and management of development activities.

One of the most important sectors for development has been the provision of potable water supplies, irrigation and power. Improvements in these areas are essential to food security and to

promoting health for the general population. Major water supply and sanitation facilities, especially those serving urban areas and economic centers, form part of the national infrastructure like roads and electricity. In rural areas improving water supplies is intrinsic to community development.

Water has been and will play an important role in the development of a country or nation or a region. There are predictions that future wars will be fought on water issues, stemming out of the social conflicts over sharing of scarce water sources. It is said that 21st century will decide the powerful nations on the basis of availability of water to a particular nation. Already different States in India have been at loggerheads over the sharing of river waters necessitating the formation of five water tribunals. Internationally, every country including India have simmering conflicts with their neighbouring countries over sharing of water.

Water resource development and management is the fundamental block in the developmental process, influencing economic development, employment, agriculture, housing, health and numerous other sectors. These benefits are spread broadly across societal concerns. Water resource development takes place in a real world setting of scarce funds, competing priorities, human resources and other institutional limitations, and social and political systems that both shape it and determine its eventual success. Both fiscal and human/institutional resources are in short supply in India. These limitations seriously affect the extent to which a country can realistically attempt to address its need in the sector.

As important as resources are the social, economic and political contexts within which water resource development takes place. Concentration of population, for example, can so far outstrip facilities development that even after many years of investment, the absolute number of people unserved may be about the same.

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Next to oxygen, fresh water is the most important substance for sustaining human life. Considered as the important one in the five elements - earth, fire, air, space and water - it was revered and worshipped and treated by all with respect. This is because a mere 1 percent of all water on the planet is readily accessible for use. Of this amount about 73 percent goes to agriculture, 20 percent to industry and the remaining is used for domestic and recreational needs such as drinking and other non-potable uses (viz., washing). But in the past two decades, the modern development and mismanagement of water resources has resulted in huge water shortages. For untold millions, shortage of water means epidemics, hunger, despair and death. Water crisis has its impact not only on people but also on the environment and other living things. Fish, birds and countless living creatures are crowded out, marooned or poisoned as industry and agriculture re-route rivers, dry up wetlands, dump waste and otherwise disrupt natural eco-systems.

What is to be done? How can we balance the many conflicting interests involved in water allocation? How can we protect the environment? How can we prevent waste and encourage behavior that supports sustainable use of our water resources? How can we provide an equitable distribution system? These are some of the questions that make water one of the hottest environmental issues today.

9.3. A DEVELOPING CRISIS

9.3.1. Importance of Water

Although water is a renewable resource, supplies are limited and finite. Only 3 percent of Earth's water supply is fresh water. Total usable supply of fresh water is over 4 million cubic kilometers.

Ground water makes up over 95 percent of Earth's usable fresh water supplies. About 90 percent of the world's population gets its water supplies from river basins. More than 200 rivers are shared by two or more countries, and more than 40 percent of the worlds' population relies on water originating in a country other than their own.

Despite its availability, water is not evenly distributed or used around the world. More than 1.2 billion people do not have access to adequate and safe water supplies. The average efficiency of irrigation systems is less than 40 percent; more than 60 percent of the water delivered never reaches the plant, or more than twice as much is delivered than is necessary.

Large scale dams have proliferated in the last 50 years as the primary method of supplying water and generating hydropower with little consideration of their social and environmental impacts. There are over 35,000 large dams (over 15 m / 50 ft. in height), and more than 110 mega-scale dams (greater than 150 m / 450 ft. in height). Two thirds of the mega-scale dams built in the 1980s were in the Third World. Dams are responsible for inundating ecologically important lands and the numerous species, while destroying the lands and livelihoods of millions of people. In India, the World Bank is currently financing 21 projects, mostly in the irrigation and power sectors,involving the forced displacement of over 800,000 people, mostly tribal and rural people.

Water is a critical element in sustaining ecosystems and biodiversity. Wetlands (lakes, ponds, etc..) sustain one third of all endangered and threatened species. Over 50 percent of the world's wetlands have been lost or degraded through dams and canal projects, agricultural development, urbanization, and contamination. Of the 8.5 million sq. kms. of wetlands worldwide, only two percent are protected under the Convention on Wetlands of International Importance Especially as Waterfowl Habitats (The Ramsar Convention).

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It is said that mega irrigation has increased crop yields by over 200 percent and is responsible for one third of the world's total crop production. But it is increasingly becoming costly, inefficient and low performing. Water prices in the irrigation sector are artificially low and promote wastage.

9.3.2. Problem of Pollution

Contaminated water supply is the major cause of disease in the developing countries. One of today's main environmental concerns is pollution - pollution from agriculture, industry, from urban growth, and from water development projects such as dams and reservoirs. All these human activities have had devastating impacts on aquatic ecosystems - damaging fisheries, coral reefs, wetlands and watersheds. By far the most serious of pollution, however, is human waste. Each year as many as four million children die because they lack clean water and effective sanitation. The amount of waste water is expected to double between 1980 and the year 2000. In 1993, the Ministry of Environment and Forests had proposed a major plan to clean the extremely polluted stretches of 13 major rivers in the country at a cost of Rs.1,115 crores.

In many areas, agricultural practices have caused extensive water contamination with pesticides and salinisation of soils and ground water. Mining and industry have caused localized water contamination with industrial chemicals and metals. In certain areas, there is pollution in ground water, attributed to natural geological conditions, like arsenic in West Bengal, and fluoride in several parts of the country. Flourosis is a major problem in Andhra Pradesh, particularly in the districts of Nalgonda, Prakasham, Chittoor, Anantapur, Rangareddy and Mahabubnagar.

9.3.3. Immediate Challenges

For many urban areas, cities and towns, how to dispose of the tons of household and municipal waste generated by all their inhabitants is the major challenge. Untreated waste water and unmanaged solid waste not only spread disease and create squalid conditions in urban slums, they also contaminate the rivers and ground water on which the cities depend. There are widespread problems with unsafe drinking water and discharge of untreated sewage.

In India, the available fresh water from both the surface and ground water is 115 million hectare meters and taking the average of 1500 cu.m per year per person as the water need, the population of India will fall in the category of water stress. At present ground water caters to about fifty percent of the irrigation requirements in our country. In addition, about 80 percent of domestic and sizable portion of the industrial requirements are also met from ground water.

The use of ground water for industrial, agricultural and domestic purposes has been increasing rapidly since 1970s. The utilizable ground water resources in Andhra Pradesh is about 3 million ha.m and the present stage of development is twenty five percent. The well population has increased from 0.7 million in 1991 to 1.4 million in 1993. Ground water development is the highest in Karimnagar district with the stage of development at 43 percent, followed by Anantapur district at 39 percent. However, there has been continuous decline of water table. During the last five years, the average fall in the water table is in the range of 0.5 meters to 4.5 meters in Rayalaseema region, 3.5 meters to 8.0 meters in Telangana region and 0.5 meters to 4.5 meters in Coastal region. Thus, there is a large scale decline in ground water in rural areas, cities and towns.

Water shortages put enormous strain on rural households, especially women, who have to travel to greater distances everyday to fetch water for the family needs. The combined effects of deforestation, water-logging, erosion, etc., finally led to a fall in the water table and to salinization problems. Eroded, over-exploited, over-grazed and deforested arid lands became more vulnerable to drought. Long and recurrent rain failures had caused additional soil erosion, thus accelerating the ongoing process of desertification.

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During a drought, the wind erodes the denuded and deteriorated soil. When the rains finally do come, the water runs off quickly from a soil that has lost its retention capacity, taking with it organic material and topsoil, and causing floods, with considerable material damage and lose of life.

Deforestation had contributed to soil deterioration and water scarcity. The denuded arid areas were directly exposed to solar radiation, to the winds and rains, and therefore to increased erosion. Deforestation of watersheds reduced the water retention capacity of the soil which together with erosion, increased silt deposits and had reduced the effectiveness of irrigation schemes and water reservoirs. Things got worse when irrigation schemes did not match dry land conditions.

Drought is seen by the lay person as a problem of water shortage due to insufficient rainfall for a certain period of time. Absence or shortage of rain and the temporary character of the problem are the most visible elements. However, the problem is apparently more complex. In theory, water shortage can be the result of weather or climatic change. However, scientists are accepting that drought must also be viewed as a recurring and periodic phenomenon, to be examined from its economic and social perspective and therefore not only in terms of the levels of precipitation in a given place. A distinction is now made between meteorological drought, which refers to the rains failing to reach a certain level over a particular period of time in a given area, and agricultural drought which refers to the fact that the combined effects of amounts and distribution of rainfall,

soil water reserves and evaporation bring about a drastic reduction of agricultural yields and livestock leading to water and food scarcity and other associated problems.

As per the United Nations Conference on Desertification (UNCOD) in 1977, desertification was defined as 'the destruction of the biological potential of the land, which leads ultimately to desert-like conditions and is an aspect of the widespread deterioration of ecosystems under the combined pressure of adverse and fluctuating climate and excessive exploitation'.

Check Your Progress - 1 & 2

1. What are the districts in A.P. where fluorosis is a major problem?

2. What are the two districts where ground water development is the highest?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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9.4. APPROACHES TO WATER MANAGEMENT

9.4.1. Dams

In the early years, great reliance was placed on technological solutions. Dams became the symbols of development the world over. However, in the post Independent India, the rage was for big dams. So far, 3,000 large, and medium reservoirs have been constructed across India. In 1950-51, irrigation was available for only 2.26 crore hectares of land. By 1993-94, this has increased to 8.50 crores of hectares. Even food grain production has increased. However, all this achievement at what cost? Twenty million people were displaced over four decades since India's independence as over 1500 dams came up all over the country. Of these only 25 percent were ever resettled. The environmental and social costs of these dams and the disparity between losers and beneficiaries were realized in the face of increasing population pressure on the land. Resentment against the big dams led to agitations in Maharashtra in the 1960s and 1970s. Similar agitations seized the projects in other parts of the country. But these agitations were project specific, and it was only in the late eighties that resentment against big dams became a worldwide issue and attention was focussed on Silent Valley, Narmada, and Tehri Projects in India.

There are 18 major projects and 71 medium projects in Andhra Pradesh. Besides these, 82,500 tanks provide water for 121 lakh acres. By December, 1992, Rs.3314.61crores have been spent on 15 major and 21 medium irrigation projects. To complete them, still there is a need for Rs.3513.68

crores. In recent times, governments were able to allocate only Rs.300 crores for major dams, and Rs.20 crores for medium projects per year. At this rate, including the annual rate of 15 percent in expenditure, expenditure can be enormous. Expenditure for the proposed 12 major projects was estimated at Rs.5,819.90 crores. Under some of the projects like Telugu Ganga, Jurala, Srisailam Left and Right canals, by 1993 not a single acre was being irrigated.

Apart from displacement, ecological and project costs, dams have been the end points for siltation caused by deforestation and soil erosion in the catchment areas of the rivers. Most of the reservoirs have lost their storage capacity by a minimum of 25 percent due to siltation. The following table shows the extent of such siltation in 11 reservoirs of the State.

	Reservoir Siltation	Lost storage Capacity Ha.m/annum	in percentage
1.	Sriramsagar	9.07	25.0
2.	Nizamsagar	6.67	56.9
3.	Swarna Project	6.19	3.9
4.	Upper Maneru	8.53	28.1
5.	Kotapalli Project	13.95	55.7
6.	Tammileru Project	6.16	7.3
7.	Bahuda Reservoir	7.85	21.3
8.	Kadem Reservoir	9.25	37.0
9.	Wyra Reservoir	5.54	39.7
10.	Osman Sagar	10.75	25.4
11.	Himayatsagar	8.72	26.5

Source : Eenadu, 27 June, 1992

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Thus, the sustainability of the dams are increasingly being questioned. Even project maintenance is not properly financed, as the experience with Kadem reservoir shows.

9.4.2. Linking Projects : Grid Concept

There are now several proposals to link the rivers, divert them and create a grid, as part of a national water resource management plan. Long back, Dr. K.L.Rao proposed a Garland scheme, wherein the rivers in the north, south, east and west would be linked through a network of canals and irrigation channels. For optimal utilization of water, a national Perspective Plan for Water Resource Development envisages the Himalayan river development proposal, inter-linking canal systems will be provided to transfer surplus flows of the Kosi, the Gandak and the Ghagra to the west. In addition the Bhramhaputra-Ganga link will be constructed for augmenting dry weather flows of the Ganga and surplus water available in the Brahmaputra and its tributaries can be transferred to south by extending Brahmaputra link up to Mahanadi.

This Plan includes linking of Ganga, Yamuna, Sutlej and the Beas. Among the Peninsular rivers, it is proposed to divert flows of Mahanadi to the Godavari system and further to the Krishna, the Pennar and Cauvery. This proposal includes the diversion of a part of the waters of the west flowing rivers of Kerala to the east for irrigating drought areas of Tamilnadu, apart from bringing new areas under irrigation in Kerala. In all 17 water transfer links have been identified. The National Water Development Authority (NWDA) which was essentially established to operationalise the K.L.Rao Garland Scheme has so far completed preliminary feasibility reports of 12 links.

But going by the current context, this plan has to overcome the constraints of finances, and balance the environmental, social and ecological costs of undertaking such projects. However, the benefits accruing out of this project themselves are under circumspect. With inter-state river water disputes, and intra-state (regional) problems of water sharing, it remains to be seen how far this concept will succeed.

9.4.3. Watershed Management and Small Water Resources

Human survival since ages depended on the relationship societies had with land and water resources. To trace the evolution of this relationship, river banks and river valleys influenced the early human settlements. Many early civilizations have flourished on the river banks, and perished in the river floods; probably, due to the faulty watershed/river basin management. However, man had come to understand the cyclical relationship of the water with the land. This understanding led to the creation of tanks using highly developed engineering techniques. The time span for such development can only be guessed; might have happened over centuries. But, this knowledge has enabled man to live wherever, and not necessarily on the river banks or in the valleys. In the mid centuries, floods have ceased to be the scourge of civilizations.

A retardation of this understanding is indicated by the present land and water conditions. Most of the historical cities which flourished on river banks suffer from want of drinking water and proper sanitation. Desertification, a major indicator of the erosion of this understanding, is witnessed in many parts of the world's upland areas. Much of the world's population inhabits these areas. The early settlement pattern indicates that desertification is not due to climate change, but due to the break in the human understanding of the land-water relationship. It is not that the brains of these people have suddenly blanked out. This break is due to the over bearing governing and social systems confident of modern technologies which were essentially developed to suit the 'Western' world conditions. In these areas, nature was bountiful and people managed their resources effortlessly for centuries.

Desertification is a socio-economic and natural process which reduces the fertility and biological productivity of the soil induced by water shortage and water scarcity to the level which characterizes deserts. It is one of the clearest results of the close and increasing inter-relationships between social and natural systems. In the past, drought was not the result of human actions because, traditional societies in arid and semi-arid lands developed appropriate economic systems for their fragile and hostile natural environments. Both agricultural and livestock systems evolved practices like crop rotation, pastoral movement and agricultural livestock combination which ensured a sustainable and renewable use of the environment as well as the recovery of the land's biological productivity.

9.4.4. Historical Perspective on Water Management

Out of the five elements of the nature, water is the most important natural element supporting life on the earth. It stimulates the entire chain action and reaction in the life process. Water is consumed

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for basic human survival and development. It is the only renewable resource available in limited quantities and is not available throughout the year in the same quantities. This very fundamental aspect challenged mankind who came up with techniques of rain harvesting.

However, this traditional institutional and social fabric has been destroyed by environmental deterioration and desertification. The precarious balance between people and nature has been upset. Changes associated with long-term ecological deterioration and the occasional drought or other disasters dealt a death blow to institutional and control mechanisms developed over the centuries or at any rate made them useless.

One such mechanism is the Traditional Water Management Systems - a whole watershed system with a tank as its central point. Historically, India and especially southern states have been following traditional methods of soil and water management through a network of more than 8 lakh tanks. Tanks are artificial lakes created out of advantageous land for rainwater harvesting and for vegetative regeneration. These tanks were variously managed largely following the principles of equity and justice in sharing these resources. Today, Andhra Pradesh has 82,500 such tanks irrigating more than 121 lakh acres directly. These tanks and the catchment areas were neglected in the past 40 to 50 years. Four and half decades of social change had a definite impact on social structure and attitudes of people towards resource management. Entire education system bypassed the traditional wisdom of resource management.

Historical evidence proves the mastery gained by humankind in developing rain water harvesting structures for irrigation and drinking water needs. The stone scriptures at Porumamilla in Cuddapah district dates back to 1302 A.D. This text provides guidelines on the need to construct such structures, and where to construct. These rain water harvesting structures are popularly called as 'Tanks' which are small water reservoirs with earthen dams. Thus, tank irrigation is an age-old established practice in India, particularly in semi-arid zones of entire Southern India.

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During subsequent periods, irrigation systems progressively developed from minor, and medium to major, depending on the technology and on the size of the structure. Recently, in the 70s and 80s, agriculture witnessed the growth of lift irrigation and tube well irrigation.

9.4.5. Tank Irrigation

Tank is a perfect example of a complete hydrological system in which inputs and outputs of material and energy can be readily identified. The geomorphological conditions in semi arid upland area favoured development of minor irrigation structures, particularly tank irrigation. Tank irrigation enabled the development appropriate situations which strengthened the social fabric in management of water resources. Restoration and rehabilitation of existing irrigational tanks is vital enough to restore the rural economy. Evolving appropriate methodology on restoration and management can lead into a sustainable development process. Today, the advantage is that most of the areas have existing structures and as such do not demand further capital investment.

Various studies on water management systems and subsequent interaction with growing communities provided valuable information on the deteriorating conditions of rural economy. Though oldest in terms of structure and management, tank irrigation in India has fallen from a maximum of about 4.8 million ha in 1960-70, to less than 4 million ha in 1975-76. Out of a total 44 lakh hectares of irrigated land in Andhra Pradesh, 26 percent falls under tank irrigation. In some parts, it is 55 percent particularly in Telangana, Rayalaseema and upland areas of coastal region.

Main factors which caused this decline of tank irrigation in extent and reliability, especially in Andhra Pradesh, are :

1. Focus, priority and investment shifted to major irrigational structures, and mega projects.

2. Local management structure was decimated by the centralized management of the Government through Irrigation Department.

3. Some are under local Panchayat bodies with inadequate management resources.

4. Farmers participation has been reduced to mere tax or cess payers, which resulted in the erosion of sense of belongingness among them towards their local resources.

5. Extensive support provided to develop individual irrigational sources through tube wells.

6. Administratively, area under tank irrigation was rescheduled as under well irrigation.

7. Environmental degradation such as deforestation, overgrazing, soil erosion and siltation.

8. Changes in land use pattern particularly in the catchment zones of reservoirs, aggravating soil erosion and subsequent siltation in tank beds.

9. Extension of rural agricultural community beyond the traditional sections - these neo-farmers are yet to acquire proper/scientific agriculture and water management skills.

10. With the growth of new agrarian society including small and marginal farmers, and individual benefit schemes, the entire socio-political system underwent change resulting in a vacuum at the community leadership level.

11. Tank maintenance has been neglected for the past 50 years or may be more, in some parts of southern India.

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9.4.6. Impact of Modern Development on Water Management Systems

1. Most of the tanks lost more than 50 percent of their water storage capacity either through siltation or damage to the bund, cumulatively, resulting in frequent flash floods.

2. Percolation mechanism was disturbed creating an overdraft of ground water resources.

3. Water regulating devices were damaged due to erosion while water management committees failed to take proper care to harvest the available rain water.

4. Catchment area farmers situation became more vulnerable than the command area farmers.

5. Shortage of water resources created conflicts among the small and marginal farmers.

6. In much of the area (almost 70%) only one crop is being raised, as is usually done under rainfed conditions.

7. Agricultural labour, small and marginal farmers are hardest hit due to these conditions.

8. Particular victimized sections are women, who are left behind to struggle, and youth with directionless path.

9. Migration to nearby towns has been growing trend for the past 1 and 1/2 decade and is ever increasing. Census data for the decade 1980-90 reveals that in most of the district headquarters and towns, population growth has touched 45 percent which is attributed to the migration of these deprived sections from rural areas.

10. Farmers particularly small and marginal have lost trust and faith in the system.

However, in the past 10 years, several NGOs across the country have been striving to revive these traditional methods while taking cognizance of modern conditions. Even the government has taken up several projects across the country, independently and also had been implementing in collaboration with NGOs. Already several such localized management systems have been revived complete with physical and social mechanisms, in several places of India. Notable among them are in Maharasthra. Rajasthan, Uttar Pradesh, Bihar, Karnataka and Andhra Pradesh. Even the state of Andhra Pradesh has declared 1993-94 as Year of Minor Irrigation, recognizing the role of these mechanisms in the revival of environmental and ecological conditions in the villages.

9.4.7. Conservation and Protection

Providing for the availability of water resources is not simple enough. They are to be sustainable which involves conservation and protection of both the quantity and quality of the water. Specific actions in this regard relate to :

* managing watersheds effectively.
* establishing water protection and sanitary zones near sources of drinking water.
* promoting practices designed to prevent the input of nutrients into water sources.
* ensuring the use of pesticides is properly controlled.
* establishing waste water treatment plants and promoting the environmentally sound use of recycled water.

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Pollution has to be reduced, waste disposal has to be improved, and ground water depletion has to be reversed. before sustainability becomes an acceptable goal. As demand for water grows, and water resources diminish, competition for the available resources is intensifying. Governments face stiff realities, with serious social, economic and environmental implications. It is this issue more than any other which has to force recognition of the principle that water should be considered as an economic goods. Along with that recognition, comes a need to evaluate the costs and benefits of alternative water uses.

Current pattern of water use involve excessive waste. There is great scope for water savings in agriculture, in industry and in domestic water supplies. There is also a need to reduce the proportion of water lost from distribution systems, through broken pipes and leaking taps.

Water resource management activities should include measures to bring the consumption patterns on par with the availability of water. Consumers need to be encouraged to use water more efficiently, to protect the existing resources from further degradation, and to opt for agricultural or industrial practices which economize on water use. Recycling could reduce the consumption of many industries by 50 percent, with the additional benefit of reduced pollution. Recycling in United States has increased enormously in the last twenty five years, and is expected to grow by the end of the century.

9.5. INSTITUTIONAL FRAMEWORK

India typically has at least five types of participants in the development process: the government (which may include State and Central governments), donor agencies (bilateral and multilateral), nongovernmental organizations, local communities and beneficiaries, and the private sector. Very broadly speaking, the basic division of labour is that the government should assume control of the development process, establishing policies and priorities. Users must be involved, but the nature of their involvement depends upon the situation; in rural areas, for example, communities should assume major responsibility for operation and maintenance. Donors can provide capital financing and technical assistance in accordance with government priorities, with nongovernmental organizations working in special areas not covered by major donors. Finally, the private sector provides investment capital or services on contract with high potential for improving efficiency.

Of fundamental importance are the community members and their performance depends on their ability in mânaging themselves and their resources. **In fact, the major challenge here is not implementation, but sustainability.** Several soil and water conservation projects have been implemented since Independence. Their success rate can be understood from the present position of drought conditions. Implementation in the conventional governmental style would at best deliver short term benefits.

Implementation would be efficient if the following aspects are concentrated upon :

A. Sustainable management mechanisms.

B. Local knowledge, simple technology and local material usage.

C. Economic development.

D. Special emphasis on landless, women, and youth through equitable distribution of benefits, and creation of income generation activities.

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Planning and implementation should necessarily involve government, voluntary agencies, and the village community, and has to be governed by the factor of 'sustainability'.

9.5.2. National Water Policy

A comprehensive policy framework is needed to ensure an integrated approach to water resource development, with rational and equitable allocation of resources, and giving priority to the poor and unserved. The most effective policy frameworks recognize the longer term perspective of water as a finite and vulnerable resource, and address the whole water cycle. They also observe key behavioral roles at all levels.An effective policy framework should also include the establishment of standards and targets, as well as a system to monitor and use them as indicators for planning and management purposes. A national water sector strategy should state the governments objectives and the methods to be employed to achieve them. It will include investment and project development guidelines, which should aim to ensure that the development of water supply reflects considerations of water resource management and environment, such as equitable distribution of water resources and the prevention of pollution.

9.6. CONCLUSION

Water will play a critical role in future human and economic development. But this must not be at the expense of the planet's resource base.

9.7. SUMMARY

A country's development process to be successful must be total and eventually over all areas of national life. Water has been and will play an important role in the development of a country or nation or a region. There are predictions that future wars will be brought on water issues. Next to oxygen fresh water is the most important substance for sustaining human life. Merely 1% of all water on the planet is readily accessible for use of this amount about 73% goes to agriculture, 20% for domestic and recreational needs.

Large scale dams have proliferated in the last 50 years as the primary method of supplying water and generating hydropower. There are over 35,000 large dams and more than 110 megascale dams. Two thirds of the megascale dams built in the 1980s were in the third world. The mega irrigation dams have increased crop yields by over 200% and is responsible for one-third of the worlds total crop production.

The use of ground water for industrial, agricultural and domestic purposes has been increasing rapidly since 1970s. The utilisable ground water resources in Andhra Pradesh is about 3 million ha.m. Ground water development is highest in Karimnagar district with the stage of development at 43% followed by Ananthapur district at 39 percent.

Deforestation had contributed to soil deterioration and water scarcity. Drought is seen by the lay man as a problem of water shortage due to insufficient rainfall. Desertification is a socioeconomic and natural process which reduces the fertility and biological productivity of the soil induced by water shortage.

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9.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Fluorosis is a major problem in the districts of Nalagonda, Prakasam, Chittoor, Ananthapur, Rangareddy and Mahabubnagar.

2. Groundwater development is the highest in Karimnagar district with the stage of development at 43% followed by Ananthapur district at 39%.

9.9. MODEL EXAMINATION QUESTIONS

1. Answer the following questions in about 30 lines each.

1. Write briefly about the importance of water.
2. Write briefly about major & minor dams.
3. Write briefly about linking of projects.
4. Write an account on tank irrigation.
5. What is the impact of modern development on water management systems?

II. **Answer the following questions in about 10 lines each.**

1. Write briefly about water pollution.
2. What is meant by desertification? Write briefly about it.
3. What are the main factors for the decline of tank irrigation?
4. Write briefly about national water policy.

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UNIT-10 : LAND USE PATTERN

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10.1. OBJECTIVES

After going through this unit, you will be able to :

* analyse the concept of land use and its dynamics,
* explain alternate solutions for sustainable land use planning,
* describe the basic issues in land use,
* describe the role of aquaculture in the destruction of mangrove forests.
* describe the social changes due to land use conversion to aquaculture.

10.2. INTRODUCTION

The particular use of a unit of land by human society is defined as land use (e.g., land used for agriculture is agricultural land use). To study the land use involves both the past uses of land and its present day uses. Land use management and planning involve social obligations, ethics, aesthetics and conservation of land.

Earth has provided for meteorological and geological diversity, cumulatively creating a base for land capacity and/or production. Land is one of the principle components of nature. Man with his skill, knowledge and intelligence initiated artificial use of land by changing land use patterns. Land use is the process by which the human society has utilized the land for furthering the well being of the society. In the past as the human society has evolved so the land been utilized for various purposes. In the early times, natural factors such as climate, mountains and water bodies have largely influenced how land was utilized. For their survival, people depended on the products of the earth's basic biological systems - crop lands, grasslands, forests, and fisheries. The carrying

capacity of these four natural systems is essentially fixed by nature. A natural grassland can support a set number of cattle or a somewhat larger number of sheep. A fishery can supply the protein for a certain number of people and the forest surrounding a village can satisfy the firewood needs of a given population.

Major civilizations have evolved in river valleys. Probably, it was for the first time in history, man has learnt to practice agriculture and live in a well knit community. Thus arose the need for allocating certain parts of settlement to certain specialized purposes such as roads, residential buildings, places of worship, commercial centres and administrative centres. Mohanjodaro, Harappa, Babylon, Cairo, Pataliputra, Athens and Delhi are some of the oldest cities where land use planning was practiced. In the beginning, the needs of society was in harmony with nature as man's needs were few. Later on as trade began to flourish, man exploited nature for his needs. Thus began the saga of man as an exploiter. Ever since this trend took place, land has been ravaged for various purposes.

There are several examples of how due to lack of foresight, land that could have been better used for a particular purpose was put to a different use and thus ultimately devastating the land. There is no better example than the present day trend of burning tropical evergreen forests in Indonesia, India, Zaire and Brazil for the purpose of converting them to agricultural land.

The interrelation between man and nature has weakened. Instead of harmoniously living in the company of nature man isolated himself more and more from nature which ultimately resulted in the artificial, energy intensive urban societies of today. Enormous quantities of natural resources from rural areas are needed to sustain urban ecosystems, thus leading to intensive mining and extensive agriculture and in the process generating even greater toxic waste material in the form of solid, liquid and gaseous forms for which large spaces of land and water bodies have to be allocated. Thus urbanization can be seen as a bane.

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10.3. PERSPECTIVES ON LAND USE PATTERN

Land use is broadly based on the following tenets :

1. The earth is essentially a closed system and it is the only suitable habitat we know of and its resources are limited. Land is a finite resource.

2. Today's physical processes are modifying the land. The magnitude and frequency of these processes, are being subjected to artificially induced changes, ever increasing day by day.

3. There are many natural processes which have restrained or spurred man to further exploit the land resources.

4. Land use involved obtaining a balance between economic and aesthetic variables. On the other hand, where this has been ignored there has been disasters.

5. The effects of land use tend to be cumulative and the results of a particular land use can be witnessed only after many years.

6. The fundamental component of every person's environment is the summation of climatic and geological factors.

In this regard, the socio-economic information needed to understand the issues, concerns, and opportunities in land use planning relate primarily to : (a) Demography (b) Literacy (c) Socio-cultural aspects (d) Land ownership (e) Economic aspects (f) People's needs (g) Institutional aspects.

Historical Perspective

Out of the five natural elements of nature, land forms an essential foundation for survival and growth of all the living species - plant, animal and human. Broadly, the regional climatic conditions and the specific location of the areas with respect to its latitude, longitude and altitude stimulates the growth of the locale specific environment/ecosystems like tropical forests, grass lands, semi arid, humid, cold deserts, hot deserts, fertile valleys, etc.

In all these different regions the locale specific environment situations influenced the local people to use the available land and its natural resources to fulfill their social and biological needs.

By definition, land use is the way of using the land or the usage of the land by man to meet his requirements.

The initial phases of the human civilization was more influenced by the locale specific natural environment. Land use should be compatible to local environment. Podu or slash and burn cultivation was the first step initiated by man by converting the land use from forest lands to agriculture purpose. Subsequent developments in human civilization appeared in the river valleys and river banks. During this period large areas of the natural forests along the river banks and in the river valleys were cleared for agriculture purposes.

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The very initiation seeded foundation for an agricultural society. The Indus Valley Civilization in Indian Sub-continent proves this historical event in terms of changes in land use. Interestingly, many of the historical towns and cities are located either along the river banks or in the river valley section. For example, Delhi on Yamuna, Patna on Brahmaputra, Rajahmundry on Godavari, Vijayawada on Krishna and Kurnool on Tungabhadra. This period had not only provided the basis for structural planning of village but also stimulated subsequent modules for planning and development of the then urban centres (historical capital towns and cities).

It is very interesting to note that the life style was eco-friendly and even the planning of physical structures like housing, temples, royal palaces were more in tune with local environment situations using the renewable energy sources. This eco-friendly interrelation can be witnessed in most of our agriculture based rural India. Also, this phenomenon is seen in most of the Asian, African and South American continents. Till this period, a change in land use is transitional and followed a graph of evolutionary path and was never anti-environment.

The world witnessed a drastic change of land use from the very beginning of the industrial development. The beginning of the industrial period heavily influenced the man in his thought process. The perspectives and the interdependent relations between man and nature drifted apart. He started treating all the available natural resources on the land i.e., forests, grass lands, water, air, animals, wild life including his own fellow being as basic inputs to profit oriented industrial products. Simultaneously, this period demanded the development of urban living.

There was, which continues even now, enormous exploitation of natural resources to build the infrastructural facilities for urban and industrial centres. Today, we witness the multiple use of the

land in the form of multistoried buildings and sky scrapers. The present situation created enormous pressure on usage of energy resources, particularly power, fuel and water. Adding to this are, the problems like migration of people to urban centres in search of livelihood. The population growth and excess consumption of land resources by certain sections of the world population created imbalance not only in the nature but also in the living standards of human population.

Today, we are using the land for our diversified needs: housing, commercial complexes, industries, agriculture, community needs and as dumping yards for garbage, industrial solid waste, etc.. Irrational changes of land use at various levels and places had not only created environmental problems but is also posing threat to human survival itself.

The following are some of the important problems noticed due to wrong planning either in land use or change in land use.

Check Your Progress - 1

Give some examples for the cities located on the river banks.

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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10.4. LAND USE FOR AQUACULTURE

Until a decade ago most of the India's coastline running over a distance of six thousand kilometers from the salty swamps of the great Rann of Kutch in Gujarat to the dense mangroves of the Sunderbans was endowed with varying landscapes: empty swamps and energetic Sunderbans; rocky cliffs, sandy beaches, backwaters, sprawling lakes, marshy mangroves and dense palm plantations. Being molded by the sea, the coastal landscape is unique and transitional. The cultural landscape along the coast too, is quite varied and is a charming mosaic of people with different cultural practices.

Initially, the Arabs, the Portuguese, the Dutch, the French, and the English traders, used the coast to trade in salt, spices, fruits, rice, fish, gems and metals. However, in keeping with the general trend of land use prevalent at that time, the frequency and the magnitude of changes were very small and did not alter the coastal ecosystem.

The geomorphic features of the coastal tract also contributed a great deal to the evolution of land use pattern along the coastline. The eastern coastal plain abutting the narrow shelf margin of the Bay of Bengal is 100 to 120 km wide. It is narrowest, just 25km, in Tamil Nadu at Tirunelveli. Economic activity tended to develop, firstly because of the fertile land rich in mineral resources and having abundant moisture with gentle slope draining into the sea.

Many ancient trading ports existed on the coast which further helped to develop economic activities. The Kalingas, the Rashtrakutas, and the Chalukyas were all seafarers who voyaged till the Malaya and China. Unlike the west coast with no indentations, the east coast is dotted with shoals and sandy islets, which provided protected breeding grounds for fisheries. While the adjacent wetlands served as habitats for water fowl and even attracting migrating birds from as far as Siberia (e.g.. the White Siberian crane).

The presence of tidal creeks, tidal bores, mud flats, enclosed lagoons and dense mangrove vegetation helps to preserve the nutrients washed away from the land making the waters offshore a fertile breeding ground for fisheries. Charles Darwin's Theory of Natural Selection and survival of the fittest will have no operational validity if the earth were not so rich in biological diversity. It is the destruction of this biological diversity that has lead to concern.

Environmentalists always believed that the structure of land use and it's relation to the function of the ecosystem is hard to characterize but is even more difficult to characterize with respect to complex coastal marshes, coral reefs, mangroves and estuaries which exist in a non-accessible marine environment. Each ecosystem has unique properties. Habitats may persist but the species are unique. Species may exist but the genetic diversity may vanish.

The linkages existing between above mentioned ecosystems is also unique. Carbon, Nitrogen. Phosphorous from mangroves support productivity in the adjacent coral reefs or fishes. Coral reefs and fishes can extract nutrients directly from the sea water by dialysis. Therefore, upsetting the nutrient balance of sea water by any means might kill, modify or extinguish the biotic resources existing in that particular ecosystem.

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10.4.1. Changing Land Use Patterns : Mangrove Forests

Mangroves are salt tolerant forest ecosystem of the tropical and sub-tropical inter-tidal regions. Mangrove forests are known by the name of "Mangal" in South India.

Mangrove forests provide a wide range of services :

1) Prevention of damage by coastal storms. They acted as barriers to winds and gales, preventing the cyclonic winds from penetrating the continent or land mass.

2) Providing a continuous supply of nutrients to the sea.

3) Mangroves are breeding habitats for amphibians, reptiles, birds and fishes.

4) Mangroves serve to store solar energy by photosynthesis and supply of oxygen.

The following are the major threats to mangrove forests :

1) Deforestation for human (fuel needs), agricultural and industrial uses.

2) Land reclamation for housing, industries, ports, roads and canals.

3) Salt manufacture.

4) Aquaculture.

To sustain increasing population in India and the world at large, marginal lands all over the world are being used for agriculture. Mangrove forests are no exception to this. Thus, a change in land use had occurred, from highly unique and productive mangrove forests to less productive and alien ecosystem. In such a system the nutrient cycling is also limited. Due to the loss of mangrove forests the resting sites of Pelicans have been destroyed (Sridhar, 1992). Pelicans require 2 kg of fish per day. Thus the destruction of mangrove forests lead to the vanishing of water birds, fishes, and the biodiversity factor so much essential for the survival of life in any given ecosystem (Darwin, 1843).

Further, the rapid extinction of the ecosystem results due to the destruction of the mangrove forests and by imposing a land use incompatible with the existing ecosystem.

Check Your Progress - 2

What are mangroves?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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10.4.2. Aquaculture in the Destruction of Mangrove Forests

Aquaculture is the result of man's urge to derive the maximum from a minimum of resources. Due to favorable climate and geomorphic features on the coasts of West Bengal, Orissa, Andhra pradesh and Tamil Nadu, land which was yielding little profits was taken over by large industrial houses. Initially, government to earn revenue from exports, encouraged the farmers to sell the land at the then existing prices without an Environmental Impact Study. The prices of these lands were very low due to marginal or even subsistence agriculture being practiced.

Thus, by changing the land use from low intensity, low external input agriculture to high intensity, high external input aquaculture, a radical transition in land use occurred within a span of ten years. Land prices have escalated by more than 15 to 20 times the original value. Therefore to maximize profits the aquaculturists turned to tracts of mangrove forests. Thus, aquaculture has tended to :

1) Escalate land prices.

2) Encroach unused and unique mangrove forests.

3) Destroy the species genetics e.g., vanishing of Siberian crane, and White pelican

4) Introducing high external input, costly biofeeds, not available to the poor farmer, such as hormones, vitamins and steroids imported from abroad.

Further, due to cutting down of mangrove forests along the coast, the green shelter belt, the soil got exposed to erosion. The chemical wastes such as chlorides, lime, nitro-phosphates and anti-biotics are some of the chemicals used in aquaculture which can effect fish production offshore. This would jeopardize the livelihood of the traditional fishermen. Many seasonal laborers who depend on the sea had to migrate to other places, mostly urban areas. This migration puts enormous pressures on the urban ecosystems and creates slums.

10.4.3. Social Changes Due to Aquaculture

Apart, from the ecological destruction due to changes in land use by aquaculture destruction of the socio-economic, and cultural fabric of the areas where aquaculture has encroached has changed for the worse.

Due to aquaculture enormous sums of money have been spent in rural areas where the money circulation was always limited when compared to richer urban areas. Liquor consumption and other social ills are on the rise. The scenic aspect of the mangrove forests are also destroyed when supplanted by aquaculture. Urbanization, which earlier did not encroach coastal areas is now extending till the peripheral margins of land and sea. The area beyond the high tide level (HTL) is also being taken over by the aquaculture farmers. Many of these newly constructed habitats do not have any effluent treatment facilities, thus, causing the pollutants to drain to the sea. Many estuaries and bays contain slimy toxic wastes which floats on the surface. These toxic wastes cause eutrophication (lack of oxygen) and radically increase the oxygen demand (OD) of the waters, diminishing the biotic life.

Water laws such as Coastal Zone Regulations (CZR) issued under the Environmental Protection Act, 1988, have been violated several times. There have been several instances in India where construction on beaches had to be banned, since they had violated the Coastal Zone Regulations under the Environment Protection Act.

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10.5. KRISHNA ESTUARY : AN ECOSYSTEM THREATENED

Krishna Estuary is a 240 sq.km area which projects out into the sea, as if deviating from the general contour of the coastal India. It is likely that this area has formed out of the silt carried by the Krishna river over years. In this area the river divides into a multitude of channels before joining the sea. As the river flattens out towards its end, sea water ingress is a general phenomenon. This situation is ideal for mangroves, and the entire ecosystem based on it. There are numerous islands created by channels, and mangroves. Any space between mangroves is locally called as Parra. One such space is Jannalaparra. About an area of 8 sq.km, this is located near Kothapalem village in Krishna Estuary. Three sides of this parra is surrounded by thick mangrove. There are number of Parras in the estuary ranging from tiny to largest, encircled with mangroves. These are the feeding grounds for various species of migratory birds. They get dried up during summer. The area gets inundated from August to February due to monsoons. High tides also help in inundation.

The estuary and its surroundings is a favorite hunting ground for fishermen. Traditionally, the main occupation of people in the nearby villages is fishing. In fact, during November and January, there is seasonal migration of fishermen from Kakinada area. Mangroves are spread over an area of 1000 to 1500 hectares, approximately. This estuary offers ideal conditions for breeding of various species of fish, and other aquatic life.

It is also habitat for different birds and mammals.

For the past three years, these parras are being encroached and converted into prawn tanks, and canals are being laid across the mangroves, and natural passages, to carry saline water to the prawn ponds. In the process, the entire ecosystem is under threat of extinction. In addition, people in their anxiety to catch prawn seeds near the estuary have been using shooting nets. Thus, they not only net prawn seeds, but also other aquatic life. After choosing what they want, the other species are left overland to die. As a result, due to over exploitation of prawn culture, several species are under the threat of extinction as already there are indicators of depletion. Depletion was indicated by fishermen who migrate annually from other areas for fishing. According to them, fishing resources are getting depleted. Consequently, migration has decreased. About 10 percent of mangroves is already destroyed.

Jannala Parra itself is under threat from a huge prawn culture enterprise nearby. Presently, the destruction of Krishna estuary is being executed with alarming fastness, and the entire 240 sq.km estuary in under peril. In fact, the entire length of 980 km of coastal wetland of Andhra Pradesh is facing this severe threat.

Administratively, the Forest Department which has the objective of wildlife conservation, is yet to decide whether this Estuary is its statutory obligation or not. Though certain parts are considered to fall under the jurisdiction of the department, there is a lot of confusion leading to inaction.

10.5.1. Western Delta Mangroves in Krishna River Basin

Mangrove ecosystems have been threatened the world over, by the 'development' patterns. Many have become extinct, and some are in the process. One such is the Perali Poguru, an extension of Krishna Western Delta Mangrove. Located about 90 km south of Vijayawada, 12 km from Nizampatnam and 35 km from Bapatla, it can be identified on the map between 15 degrees 49' - 15 degrees 53' North Latitude, and 80 degrees 27' - 80 degrees 40' Longitude. Administratively, this area falls under Guntur district, in the Southern state of Andhra Pradesh in India.

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It covers an area of 1500 hectares, and situated at the conflux of Perali drain, Nallamada drain and the Bay of Bengal. From the conflux, a mangrove forest exists along a creek with narrow channels between 80 degrees 32' and 80 degrees 40' East of longitude. On one side of this side, there are sand dunes and shrubs along the shore. Presently, the reserve forest is nothing but cashew nut plantation. A small pocket of bushy habitat with soap nut trees is left near Peddapuluguvari Palem. Mud flats can be seen near Nizampatnam and Peddapuluguvari Palem. The mud flats at Nizampatnam were destroyed due to the extension of the township, agriculture and prawn culture. At Peddapuluguvaripalem, during high tides, monsoons and depressions, the mud flats are inundated. Generally in inches, the depth of water increases to two feet approximately during heavy rains before joining the creeks. During summer, these flats get dried up. Various species of shore birds and some other wetland waterfowl visit this area.

The Perali Poguru (conflux) on 80 degrees 32' East Longitude is an important place for roosting of various species of gulls and terns. During low tide, it is a feeding ground for various shore birds and other wetland birds.

A small narrow channel, between 80 degrees 30' and 80 degrees 32' East Longitude, from conflux to Bapatla - Suryalanka Road, transfers sea water into the area during high tides, which forms into small pools of saline water. Even here, there is some presence of mangroves. Some areas remain wet throughout the year. A portion of land towards the sea shore consists of salty sand pans. These pans dry up after winter, and is a good roosting place for hundreds of waders on

dried sandy flats. The channel is bordered by reserve forest with cashew nut and casuarina plantation at one side and sand dunes with shrubs and sand binders(creepers) on the other side along the shore. Within the channel, there are small islands of shrubs, now invaded by Prosopis Juliflora. Though the depth of standing water is not much, it increases during rains and depressions. The salinity of water normally is E.C. 31 and pH 7.85. Seasonal analysis of salinity needs to be done.

From Bapatla - Suryalanka Road to Pandurangapuram, between 80 degrees 30' to 80 degrees 27' East Longitude, the area is sandy and gets inundated entirely during monsoons and depression. As this is sandy, the area dries up during midwinter, and is a good potential place for various species of shore birds along with water fowl. The reserve forest which borders this area consists of cashew nut trees. Between this sandy area and the shore, there is an Air Force Station, and a stretch of land where under social forestry, eucalyptus and casuarina plantations were raised. The vegetation in the Air Force Station is almost undisturbed, so far. It represents a good shrub jungle, with various species of shrubs, creepers, herbs and plants. Here also the Prosorpis Juliflora is invading the forest, but couldn't spread easily as in the adjoining areas since the jungle is thick.

The climate in the region is generally hot and humid, with temperature varying between 20 degrees and 44 degrees C. It receives rainfall from South-West, North-East monsoons and cyclonic storms due to depressions. The average annual rainfall is 1000 mm.

The principal vegetation is Mangrove, apart from other species

Generally, the area is under Forest Department. Along the seashore is the revenue land, under the Revenue Department. At Pandurangapuram, a little piece is owned by private farmers.

This area is an important destination for local and migratory birds. It is a good resting place for migrants passing through like spot-billed pelican, painted storks, and flamingos. About 110 species of birds have been observed in this area. The black-winged stilts visits this place during August/September. Along with these, Pond Heron, Cattle Egret, Little Egret, Medium Egret and Large Egrets visit this place. However, since three years white necked storks and purple Heron are not to be seen. It seems even Glosy Ibis and White Ibis have also reduced their visits.

Further, extending towards Krishna River, the habitat is an excellent wetland with dense mangroves, scrub jungle, muddy flats, islands, sandy mats, etc.

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10.5.2. Conversion of Land Use

Traditionally, the area is used for cattle grazing and fishing. Gradually, with growing urban demands from the nearby towns of Bapatla, and Nizampatnam, the pace of mangrove deforestation increased. The wood of these mangroves is sturdy enough to be used as household beams. Mangroves are being cut for firewood and fodder needs also. Human ingress into this ecosystem can be seen in the form of bird poaching, mechanized boats, modern techniques of fishing and killing of various species for different purposes. With the destruction of mangroves, habitat for different wildlife, many species have become vulnerable to man's deeds.

In recent times, agriculture is being practiced for which land is being cleared of any vegetation. Whenever there are high tides, rains and depressions, soil gets eroded on this land which lies exposed. Of late, prawn culture has become the top-of-the-agenda activity for the people in the coastal parts due to its export potential and quick economic returns. This led to encroachment of

lands, wherever possible, leading to destruction of habitats, and a major upset in the balance of nature.

Mangrove deforestation, devegetation and prawn culture are increasingly threatening the delicate balance between the land and sea. Salinity of the land is increasing affecting the inland vegetation. Soon we may see a different type of desertification. Destruction of mangroves, a natural barrier, leaves the land with no protection against cyclones, and high tides. In the near future, sea ingress is likely to wipe out this entire ecosystem.

10.6. CONCLUSION

As the human population grows and 'develops', the competition for lands increases. Conflicts over land use are bound to be more frequent, and with development, industrialization and growth of cities, they will doubtless be more severe. Thus, open and common lands will be under growing pressure from 'developers' and development. Growth of cities, population shift towards urban areas, population growth, resource exploitation for mining of materials, industrialization, intensified commercial agriculture, etc.. are likely to increase the hunger for land, and thus land conversion. In this context, land use planning is called for an effective sustainable development.

Conversion of land use to suit human needs without any consideration for the balance of local ecology has led to disasters like soil erosion, land slips in mountain areas, severe water shortage, pollution, decline in soil productivity, loss of top soil, and greater and devastating impact of natural disasters like cyclones and drought.

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There is a growing school of thought on common property resources which also includes a call for preservation of common lands for common usage, and environment-friendly activities. Various institutions have been doing and encouraging research on assessment of past land use patterns, present conversions, cost and benefits of such conversions, and alternative strategies. While the government has been undertaking several measures for preservation of forest lands (to prevent further conversion of land usage), it is also encouraging efforts at efficient usage, and restoration of land use patterns. Thus, urban (town and city) planning aims at maintaining a balance between needs of the people and the constraints of the local environment. Secondly, projects on watershed development and management by the local communities are increasingly being taken up by both the government and the non-governmental organizations.

10.7. SUMMARY

Earth has provided for meteorological and geological diversity, cumulatively creating a base for land capacity and/or production. Land is one of the components of nature. Man with his intelligence initiated artificial use of land by changing land use patterns.

Major civilizations have evolved in river valleys. Man has learnt to practice agriculture and live in a well knit community. Mohanjodaro, Harappa, Babylone, Cairo, Pataliputra, Athens and Delhi are some of the oldest cities where land use planning was practiced. The world witnessed a drastic change of land use from the very beginning of the industrial development. He started treating all the available natural resources as basic inputs to profit oriented industrial products.

Aquaculture is the result of man's urge to derive the maximum from a minimum of resources. Due to aquaculture enormous sums of money have been spent in rural areas where the money circulation was always limited.

10.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The examples are Delhi on Yammuna, Patna on Bramhaputra, Rajahmundry on Godavari, Vijayawada on Krishna and Kurnool on Tungabhadra.

2. Mangroves are salt tolerant forest ecosystem of the tropical and subtropical intertidal regions. They are usually called by the name 'Mangal' in south India.

10.9. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Write briefly on Aquaculture.
2. What are mangroves? Write briefly about them? What is the threat for mangrove vegetation?
3. What is the threat for Krishna estuary?

II. Answer the following questions in about 10 lines each.

1. Write about mangroves.
2. What is the role of Aquaculture in the destruction of mangrove forests?
3. What are the soical changes due to land use conversion to aquaculture?

BRAOU

Mr. B. V. Subba Rao

UNIT-11 : AGRICULTURE

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11.1. OBJECTIVES

After going through this unit you will be able to :

* describe the effect of modern agriculture on land use, the natural resources and the climate,
* explain the damage caused to fertile soils by the use of heavy chemical inputs and heavy machinery,
* describe the disruption of local social structures, increase of water-borne diseases abd salinity of the soils,
* explain the destroyal of natural forests to grow export crops.

11.2. INTRODUCTION

India has been more affected by drought and associated famines than any other country in the world. Over 80 percent of the subcontinent is chronically drought-prone. It has suffered atleast a dozen great famines in which a million or more people have died in the past 1000 years. There have been four major famines in the past 100 years.

Faced with the twin problems of population pressure and land scarcity, policy thrust has been to increase agricultural production by intensifying cultivation on a more or less fixed land resource base. Whether this has been successful in keeping the growth rates of agricultural production ahead of population growth rates or not?, and whether this growth can be maintained in a environmentally sustainable manner. For this, it is important to understand the existing production and consumption linkages and their impact on the nutritional well-being of people. However, at the outset it can be said that changes in farming system and application of specific technology had its impact on food consumption and nutrition, if not on production. Earlier, the economic situation in many developing countries has propelled the household to resort to a great variety of income sources just to survive. With modern technology and Green Revolution, the situation is no longer the same: people now have limited access to dwindling resources, thus affecting their chances of survival and subsistence existence.

Green Revolution as a policy prescription marked a distinct change in the history of agriculture and management of resources. Technological changes introduced have ushered in a new era of science-based agriculture bringing farmers to novel ways of thinking about and managing the farm, in contrast to the traditional methods of agriculture.

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11.3. GREEN REVOLUTION

The Green Revolution launched in the 1960s was hailed as a means to eradicate hunger and poverty in the Third World. Today, 20 years later we see the results: higher incidence of crop failure, increased vulnerability to drought and desertification in the arid regions of the world, and thousands of indigenous seed varieties from the Third World siphoned off to enrich the seed banks of the industrialized nations.

Green Revolution (GR) has turned out to be a myth. Its aim was to increase income and yield, to enhance greater economic prosperity. Hence, synthetic fertilizers, sturdy hybrid strains, pesticides etc., have been introduced. In the early stages of green revolution, high yields were obtained. In some years, abundant harvest resulted and a bumper yield of grains has ensured. The farmers also rapidly adapted themselves to this new scenario. Traditional strains of grain were replaced in the farms by new short hybrids. Bureaucrats and scientists were trained in agriculture advertised for green revolution in an all-out massive effort.

The Green Revolution which was planned for the semi-arid plains of North India simply played havoc with traditional agricultural practices. Encouragement to monoculture and hybrid seeds - for which initially lucrative incentives were given - began to erode the species and genetic diversity of crops. Eventually these led to an actual fall in grains as well as hay output. Chemical fertilizers caused hardening of the soil, pesticides killed natural preys, resulting in attacks by pests and diseases not known before. Equally important, the Green Revolution (GR) sought to change the people's attitude and approach towards agriculture. From being sacred, it became 'soul-less' and market-oriented. Earlier, seeds were considered as gifts of god and never sold but freely exchanged among the people. Now these became a marketable commodity.

'Cash' came to represent the over-riding factor in agriculture, at the cost of the wholesomeness of food and life. Though certain individual farmers and those in relatively isolated villages had not given up all their native seeds or traditional agricultural practices, such instances are comparatively few and scattered.

One major consequence of the GR has been its negative impact on nutritional levels. And nutritional Levels were reduced because of the decline in production of pulses. From 64 grams in 1962, the availability of pulses per head per day has decreased to 58 grams in 1964, to 48 grams in 1971, 45 grams in 1976, and only 40 grams in 1979. Ashok Thapar observed, in Times of India (22 June, 1971), "Paradoxically enough, the spurt in the production of foodgrains has in many ways only aggravated the problem of nutrition. There has been a 16 percent drop in the production of pulses, an important source of protein in vegetarian diets, as more and more pulse growers have switched to the more profitable cereal crops".

11.3.1. Monoculture

GR is essentially a revolution in single commodity i.e., wheat. From 6.8 million tons in 1949-50, the wheat output rose to 12.2 m tons in 1964-65, to 16.5 mt in the first year of the GR, 1967-68, to 26 mt in 1971-72, 35 mt in 1978-79, 38 mt in 1981-82, and 46 mt in 1983-84. This has aggravated the problem of malnutrition. There has been a 16 percent drop in the production of pulses, an important source of protein in vegetarian diets, as more and more pulse growers have switched to the more profitable cereal crops. The share of wheat in the total foodgrain production rose from a mere 13 percent in 1963-64, to 22 percent at the cost of rice, pulses and other crops. While the yield of wheat rose by 62 percent, the yields of rice, pulses and other crops remained static.

The reason for this imbalanced growth between wheat and rice, according to Dr.J.K.Bajaj, is simply that the Western countries, where the new technology evolved, are no rice-producers. In 1983, high yielding varieties were sown only in 54 percent of the rice lands. In 1987, 69 percent of harvested rice area was covered with high yielding varieties. The National Gene Bank in Delhi has a capacity to hold 6,00,000 accessions, but only 7,000 rice varieties are in long term storage there. In Sri Lanka, farmers were growing 2,000 traditional varieties in 1959, today essentially only five varieties are grown. Genetic erosion is equally evident in cereals, fruits, vegetables and root crops throughout the world. The process of genetic erosion has not declined over the past decade despite increasing awareness of this issue.

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11.3.2. Cash Crops

Due to the lure of high profits through export of cash crops like tobacco, cotton, etc., hunger for land increased enormously. Also, increased usage of fertilizers and pesticides in the hope of earning quick profits through high yields and it made most lands lose their regenerative capacity having been heavily chemicalised. Thus, the cash incentive increased the hunger for virgin lands. This necessity pushed the farmers to destroy forests.

Cash crops demand more cash investments from the farmers in the form of chemical fertilizers, mechanized inputs and linkages to a market based on cash transactions. A subsidized farmer under present type of dispensation is gradually forced to become a dependent parasite. In the process, managerial skills of the individual and the community are lost.

11.3.3. Chemicalisation

Usage of chemical fertilizers, promoted under GR, had resulted in the decline of soil fertility. Normally, soil sustains itself by naturally breeding earthworms and other living organisms which in their turn help to cultivate good crops. These worms and insects feed on natural manure, not chemical fertilizers, which in fact kill them; unlike fertilizers, manure is supposed to improve the fertility of the soil. These living organisms which sustain the agricultural cycle were destroyed. Thus, the chemical fertilizers inhibit the natural process. Also, short hybrid strains of GR are more prone to attack by pests.

Pesticides are very potent - pesticides are basically poisons and do not have any healing properties. But even they are no match for the new generation of pests that have now emerged. That is the reason why scientists who initially favored pesticides are now campaigning for alternative approaches. Resultantly, farmers have been forced to abandon cultivation of certain crops which are cannot survive attacks by new generation of virulent pests. In Coimbatore, cotton cultivation has been sabotaged by white flies which attack the pods inspite of the most toxic of pesticides. Unfortunately, in the battle launched by scientists against nature, farmers have turned out to be the losers.

DDT was considered as a cheap, effective and a moderate chemical pesticide. Though it was developed in 1874, its pesticidal properties were known only in 1932. By 1942, DDT was thought to be a god's gift to mankind.

DDT was used the world over to control Malaria. It was so effective that it was hoped that DDT would wipe out the entire insect varieties. Gradually, several negative factors were noticed. Factors such as its ability to penetrate and remain in vegetables and animals, retention in fat, remaining in the environment for a long time and poisoning it, etc., and the resistance developed by the insects/ pests. Finally it's use was banned. Rachel Carson's 'Silent Spring' details the effect of DDT on environment and people.

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The ill effects of prolonged use of the pesticides are many. But three most important effects of prolonged use of pesticides are: large scale killing of the other useful insects and predators; quick resistance developed by the pests to the pesticide; and, the uncontrolled growth of the pests due to the elimination of the predators. Bird population has drastically reduced due to the consumption of pesticide-affected insects and pests. In the past, birds were also pests on crops such as sorghum and millet, but not so now.

These effects caused the scientists to change their views and move towards protecting the natural enemies of these pests, enhancing their population and use them for pest control. Thus was born "biological control" or "bio-pesticides" aimed at combining chemical and biological pest control. The current trend is a mix of these two methods together with other methods.
There has been a new awareness on the pollution of land, water and air by poisonous insecticides. It is therefore essential now to re-direct research towards reducing to the bare minimum use of poisonous chemical insecticides and to adopt biological pest control methods which are harmless and support the environment.

11.3.4. Exports and Equity

Before GR, import of chemical fertilizers was virtually non-existent, and most of the inputs came from agriculture itself. Total chemical nutrients used in India's agriculture increased from 785,000

tons in 1965-66 to 4497,000 tons in 1978-79. Imports increased from 334,000 for the period 1961-66 to 1992,000 in 1978-79. Rough calculation comparing the imports and exports indicate that net wheat imports in the post GR decade increased by 50 percent.

Contrary to the belief, the industrialized West is becoming increasingly dependent on Third World imports, and this inspite of food-aid programmes and increasing food imports by Third World countries.

Panacea to Export : Following certain economic theories, governments have been encouraging exports of agricultural produce. Parallel to this, in order to maximize export earnings and to decrease input costs, there is a trend towards large landholdings and mechanization of agriculture by the Market. This trend is backed by the government with subsidies, incentives and reliefs. Also, since long time, government has been contemplating to accord industry status to agriculture.

However, export orientation demands cash inflows which are beyond the means of small and marginal farmers, and deprived sections. Further, indiscriminate exports or exports which chase international prices have had a negative bearing on the domestic commodity prices. Agricultural export enables the encouragement of only those crops which have international commercial value. As a result, cropping patterns across the country get limited to a few cash crops irrespective of environmental and ecological conditions. Consequently, export as an activity has come to mean conversion of resources into foreign currency.

Exports can be useful only when there is an exchange of goods and resources on the basis of need rather than on the anxiety to build cash reserves. And, also export can be done only when there is a surplus.

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11.3.5. Productivity

GR was based on an assumption productivity (during the years before the GR) had reached a saturation level. Thus, the new technology became necessary to increase the rate of growth of productivity. However, during the Third Plan period (1961-62 to 1964-65), the rate of growth of productivity was 2.7 percent per annum compared to the annual growth rate of 1.4 percent and 1.8 percent achieved during the First and Second Plans (Dr.J.K.Bajaj). And, during the Fourth Plan period it had declined to an all-time low of 1 percent (in the years of GR). Another author on the GR, B.M.Bhatia, had observed that total foodgrain production increased from 54 mt in 1949-50 to 89 mt in 1964-65, roughly 65 percent. In the post GR period, there was an increase from 95 mt in 1968-69 to 151 mt in 1983-84, a mere increase of 57 percent. By 1984-85, total output has declined to 146 mt. This zig zag pattern exposed the vulnerability of agricultural production to the vagaries of nature, irrespective of technology.

Check Your Progress - 1,2,3 & 4

1. What were the aims of Green Revolution?

2. What are the most important inputs of Green Revolution?

3. List out major negative consequences of Green Revolution.

4. Which book describes the impact of DDT on environment and people?

Note : (a) Write the answers in the space given below.

(b) Compare your answers with those given at the end of this unit.

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11.4. LAND AND WATER MANAGEMENT

11.4.1. Land Use Pattern

The four main causes of desertification are : over cultivation of poor soils, overgrazing of semi-desert, serious deforestation and poorly planned or maintained irrigation projects.

The total area subject to water and wind erosion is estimated at 144.1 million ha (1984-85): 48.5% of India's total land area. Average annual loss of plant nutrients from eroded soils is estimated at between 5.4 and 8.4 million tonnes. Some 1 million ha are deforested per year, 8 million ha are affected by flooding, and 3.7 million ha of the cropped area is affected, directly or indirectly, by degradation annually. It is estimated that prevention of annual soil and plant nutrient loss could add 30 to 50 million tonnes to the country's agricultural production.

As an important part of this country, Andhra Pradesh witnessed such changes variously. However, the impact of these changes in general on the society and particularly on the poor have sometimes gone unnoticed, sometimes ignored, and most of the times not understood at all. Some of these changes are fundamental: key to survival itself. They are, as an example: changes in land use pattern and changes in land lease Act.

In recent years, fertile command areas of the Krishna, Godavari and Penna underwent a transformation from lush paddy fields to aqua farms (1,40,000 hectares, approx.), both fresh water and saline. The impact of such a change in land use pattern in such a short time span has its ramifications on the food production levels, and socio-economic conditions. This change alone necessitated the migration of about 5,00,000 landless agriculture labor - in search of new pastures.

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However, aquaculture understood in its broadest sense induced a good economic boom in the area. But, the mute question is whether even one percent of the net profits were ploughed back into the local economy to provide alternate source of employment. Without getting back the financial returns, and the consequent enhancement in the standards of living of the majority, this sudden transformation of agroecology has brought in other problems like nonavailability of fresh water for drinking purposes, and other related environmental problems. Today many villages in the coastal districts suffer from shortage of uncontaminated drinking water. As a result, and also independently, large percentage of labor migrated to urban areas.

The other major under-the-mat change is the changes in land lease Act. Today, any agro/land resource based industry can acquire land to the tune of 2,500 hectares in the dry land areas. Such a change definitely goes against the spirit behind land reforms in this country, and espousal of social justice. A feudal landlord is replaced by a corporate entity. In this context it has to be remembered that land is the most important resource. Its control pattern decides the socio-economic conditions of vast number of people. The Corporate sector is now coming out with a novel idea of influencing the small, marginal farmers to join as 'Share Holders' by leasing their lands. It remains to be seen as to how the small and marginal farmers will benefit from such a system. Remnants of land reform movements (Sarvodaya, Bhoodan and leftists) failed to react to these changes, methodically and constructively.

Consequent to changes in landuse pattern, there is growing pressure on the fragile ecosystem of hilly terrains, to be converted for agriculture use. With the changing situations, there arises a greater need to focus on distribution of land productivity also on an equitable basis.

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11.4.2. Modern Irrigation Systems

Expansion of irrigation sources was an essential activity of developmental programmes in many countries of the world with the primary objective of bringing about substantial improvement in the rural economy. It is believed that irrigation plays a vital role in enhancing agricultural production and in minimizing adverse effects of vagaries of climate, particularly in the arid and semi-arid regions where the rainfall being scanty, erratic and uneven, is not able to meet he entire water requirement of crops in different seasons and years.

Though irrigation was practiced since ages (India has some of the oldest irrigation systems), it was given priority after Independence in various Five Year Plans. As a result, irrigation potential has increased three times from 22.6 million ha in 1950-51 to 67.9 million ha in 1984-85. It is further planned to achieve a target of 113.5 million ha by 2010 A.D.

Irrigation water can be blessing or a curse depending on how it is used. Salinity of soils is the consequence of haphazard irrigation. About one-third of the irrigated land at the global level is reported to suffer from soil salinity, and every year additional areas are being engulfed by this menace with the increase in irrigation use. Also, inefficient management of irrigation water disturbed the hydrological equilibrium resulting in substantial groundwater recharge with consequent rise in water table. Thus, several thousands of hectares of fertile lands have been affected by waterlogging in many irrigation projects in India because of recharge being greater than discharge in the absence of effective drainage.

Poor irrigation efficiency led to widespread waterlogging promoting excessive weed growth, impaired microbial activity, caused disorder in nutrient availability, affected soil health, exerting

harmful effects on plant growth and had created unhygienic conditions for human beings. The yield of foodgrain crops in irrigated areas is less than the average yield level under well-managed irrigation systems.

Besides, irrigation projects required huge investments at the cost other cheaper options, occupied large areas inundating precious soils and ecosystems, and are feared to induce earthquakes. These projects have also caused human misery by causing largescale displacements of population, particularly the tribals, and had created the process of desertification through deforestation. Thus, they have been the cause for decimation and loss of unique species of flora and fauna, and the tribal culture.

11.4.3. Resources

Indians have traditionally been great water harvesters - possibly the best in the world. All across the country there are numerous traditional technologies to collect and store rain water. Jodhpur, a major city of the dry Thar desert, once had a very good system of water harvesting but which has been destroyed over the years. The entire catchment of the tanks in this city has been destroyed and turned into quarries for the famous Jodhpur stone. Out of the 14,000 hectares of the catchment area, about 11,000 hectares is under 10,000 stone quarries. The entire landscape is scarred with deep craters created by the quarries, many of which have been abandoned. This is not only true for Jodhpur.

In almost all places, traditional water systems are in a state of disrepair and mismanagement. As modernization brought people piped water supply, they began to neglect their traditional systems and depend on the government. These traditional structures demanded not just engineering skills but also social discipline. The modern potential of these systems is enormous in the water-starved towns and villages of India.

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In fact, it was found that distant villages, which had not yet benefited from government water schemes, had some water to drink as they still had their traditional systems intact. The 'developed' villages, however, are starved of water - tubewells had either no water or no electricity to pump it.

11.5. TRADITIONAL AGRICULTURE

Agriculture in India encompasses regions of a variety of agro-climatic and cropping systems. It also faces innumerable problems of equal number. Yet, it has sustained itself, notwithstanding, the alternating droughts and floods, survived without modern energy resources, scarce financial and physical resources, pests, swarms, etc..

India is one of the many nations involved in farming activities for over several thousand years. In ancient times, farming was essentially a way of life. Agricultural activities and techniques were tailored to suit the soil conditions, rainfall, sunshine, wind, etc., in different places. Selection of crops to be cultivated was made consistent with what is popularly known in English as 'Photoperiodism'. The entire activity was primarily based on the local conditions in different parts of India. Different rice varieties were cultivated in different areas depending on the local weather and soil conditions and demand.

Farmers developed their own systems of farming, within the framework of local possibilities and limitations of ecology and the social, economic and political structure of their habitations. India is a land of agriculture: Indians have paid great attention to agricultural technologies and agronomic

practices and had achieved great sophistication in these areas over the centuries. Farming is still done according to the traditional methods in many parts of the country.

Many of our farmers are authorities of traditional agriculture and repositories of traditional wisdom. The knowledge is propagated in many forms such as folk songs, rituals, proverbs, and riddles by which the art of cultivation is handed over from generation to generation. There are also scholarly texts on Indian agriculture. But, much of the existing knowledge of traditional agriculture has not been consolidated and put together. No systematic work has been done in recent times in bringing this knowledge to light. A great deal of work needs to be done in this area. This knowledge of traditional agriculture needs to be not just documented but also has to be encouraged and helped to take its rightful place in the context of the modern knowledge.

There are a large number of manuscripts on Vrikshayurveda which are unexplored. There are separate sections of Indian agriculture like Agnipurana, the Brihat Samhita and Arthasastra. A pilot study of these texts and manuscripts reveal that the subjects dealt within the ancient science of agriculture consisted of collection and selection of seeds, germination, grafting, cutting, sowing, planting, nursing, selection of soil under favorable meteorological conditions, pest and disease management, nomenclature and taxonomy and botanical novelties.

Maintaining a healthy soil and choosing a right one are important aspects of the agriculture. Knowledge of soil and care for its health formed an important part of plant science. The land and its proper utilization occupied an important position in agriculture. In ancient India, farmers were quite conscious of the nature of the soil and its relation to the production of specific crops. Soils were classified based on fertility, on specific crops grown, based on ploughing and also on the nature of soil and climate. Sophisticated techniques for testing and improving the quality were known. Collection of seeds, their preservation, treatment and methods of preparing them for cultivation are important agricultural practices. Grain storage practices were also highly sophisticated.

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Presently, traditional systems are being recognized as extremely important even in this world of modern science and technology. Their ecological rationality remains valid in the modern context. India's organized knowledge generating systems like its universities and the vast array of social science and scientific research institutions have almost totally neglected traditional knowledge systems. A fresh evaluation of traditional systems can also have major political and cultural repurcussions.

11.5.1. Seeds and Germplasm

According to Dr.Richharia, rice scientist, four lakh varieties of rice existed in India during the Vedic period. His estimate is that even today two lakh varieties of rices still exist in India.
Every variety has specific purpose and utility. Farmers in every part of the country have deep knowledge of their own varieties of rice, of their environmental and nutritional requirements, properties and peculiarities. This enabled them to harvest a crop even under the most severe stress situation. Farmers also possess high yielding varieties of their own which are not recognized in agricultural extension programs. Studies show that yields as high as 12 tons of paddy per hectare were realized in Chengalpattu region of Tamilnadu around the middle of the 18th century.

11.5.2. Practices and Social Conditions

In those days every farmer possessed cattle also. Bulls and cows were part of his assets. Milk and buttermilk were never sold for profit. The farm-hands were generously given these free. In most places there existed a cordial and affectionate relationship between the landlord and the laborers.

The latter were provided lunch everyday in the landlord's house. On festive occasions like Deepavali, new clothes were gifted to them by the land lord. In sharp contrast to the prevailing conditions now, the laborers of those days worked for their landlord with complete dedication and responsibility. Since only natural resources were used, the agricultural products had good quality, taste and nourishment. The type of food consumed by people was also dictated by the seasons.

In short, farming was a way of life based on sound human relations, discipline and loyalty. It was not just a profit-making proposition. People were content with what they had, the land was nurtured with care, pesticides were unheard of and cattle flourished.

11.6. POLICY IMPERATIVES

The entire business of clearing the heavy financial loans taken by farmers for purposes of modern farming is alarming. Despite the Minimum Support Price policy, government does not give a profitable estimate of the selling prices of agricultural produce. On the other hand, prices of things necessary for farming as also for general day-to-day living are getting higher and higher. Further, the heavy interest on loans given to farmers is a formidable problem. The bitter truth is that any returns from the land are at best used by farmers to pay off the heavy interest alone.

To top it all, for about thirty five years now rainfall has been erratic and soil fertility has gone down. Farm hands are in short supply at much-needed times. Due to all these reasons, educated youth do not wish to take up farming which has now become a thankless occupation.

11.6.1. Subsidies

The economic strategies based on subsidies also contributed their share in undermining the scope for agricultural development. Providing subsidies as a policy for rural people, especially to marginal and small farmers, though has a good intention, the way it came to be projected and implemented created a attitude of dependency. Subsidies are generally associated with the agricultural inputs. But this culture permeates other areas as well. However, there are conditions which necessitate the application of such an approach. At the same time, application of such approach in general, continuation for long periods and inadequate monitoring of its effect and result, have wrought in attitudinal changes which proved to be detrimental to the managerial capacities of the local communities.

Today, agricultural community depends for every agricultural input on the government to pursue their agricultural activity. This dependency is not only at the production stage but also while marketing the produce. Rapid depletion of draught animals forced them to hire tractors for ploughing. Decrease in animal population also created shortage of farm manure. It increased their need for cash every time they initiate agricultural activities. Depletion of certain tree varieties particularly used for green mulch practices, led to erosion of traditional practices. These and other changes led to circumstances wherein farmers came to depend more on market, and subsidy for procuring agricultural inputs, like chemical fertilizers.

Further, the market oriented economy is heavily influencing the farmers to shift to cash crops like cotton, tobacco, oilseeds, mulberry, etc. As a result there is drastic drop in the acreage under food grains. For a farmer, even this shift is not profitable or enduring as the returns are not adequate to meet his bare minimum needs of food and other neccessities. In the end, neither the farmer is benefited nor the society at large - environment and ecology also suffers.

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11.6.2. Research, Extension and Education

Indian society has its own communication system of transmitting information of pre-historic period to the present generation through cultural forms, traditions, rituals, and cultural groups. They are rural based and are capable of blending the information with legendary proverbs to suit the rural psychology. Through the experience of past generations, the knowledge of which is obtained in the above mentioned forms, farmers have been making their own innovations and selection of appropriate technologies. Sometimes they select technologies which have been rejected by official researchers.

An interesting example is that of the paddy variety called 'Mahsuri' which was used by scientists for tests during 1967-68. Rice breeders rejected this variety because of its lodging behavior. However, this seed reached a farm in Andhra Pradesh through some villages. Farmers who tried it out found that it performed extremely well. Subsequently, it has spread from Andhra Pradesh to Orissa and then to West Bengal, Bihar, Uttar Pradesh and parts of Madhya Pradesh. As a result of this farmer to farmer extension, 'Mahsuri' is now the third most popular variety among the Indian farmers. Several such examples could be cited which illustrate the need for farmers becoming partners in agricultural research, planning and policy making, and also that traditional knowledge should be taken seriously.

So far, no agricultural University or research centre has attempted to develop a feasible module for small land holders. Present research objectives focus on large holdings, and demand heavy financial inputs.

11.7. ECOLOGICAL AGRICULTURE

11.7.1. Emerging Methods

Emerging farming methods are still not a well-defined set of practices or management techniques. Rather, they are a range of technological and management options used on farms striving to reduce costs, protect health and environmental quality, and enhance beneficial biological interactions and natural processes. These methods, if followed efficiently, nearly always use less synthetic chemical pesticides, fertilizers, and antibiotics per unit of production than comparable conventional farms. Reduced use of these inputs lowers production costs and lessens agriculture's potential for adverse environmental and health effects without necessarily decreasing, and in some cases increasing, per acre crop yields and the productivity of livestock management systems.

In Holland, Israel and other countries, the concept of green-house farming is being implemented with the aid of computers and low man power. The situation in India is different. Organic farming is the method, and concept, which is increasingly gaining ground here. This type of farming advocates total renunciation of anything chemical, depending only on natural and organic material.

11.7.2. Future Prospects

There has been a great resurgence of interest in recent times in studying traditional methods of agriculture. The interest has been world-wide and has encompassed diverse areas of plant science such as agronomical methods, soil testing and soil classification, pest control and crop protection techniques, irrigation, climatology, forestry, nomenclature and taxonomy to name just a few of

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these areas. These studies have become extremely important in the light of the world-wide efforts to seek alternatives to modern agriculture and evolve sustainable eco-friendly strategies for development.

Current scientific, technological, economic, social, and environmental trends are causing farmers to reconsider their practices and look for alternatives. Emerging methods hold promise and potentially significant benefits for the people. However, the transformation can be slow. Because it depends on the farmer's individual choice, economic opportunities and incentives, government policies, market forces, research priorities, and the importance society places on achieving environmental goals. However, this change will require fundamental reforms in agricultural programs and policies. Also, farmers will have to acquire new knowledge and management skills necessary to implement successful alternative practices.

Check Your Progress - 5

What are the environmental effects of modern irrigation systems?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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11.8. SUMMARY

Modern developmental processes enabled humans to exploit natural resources indiscriminately. Forests, minerals, water, air and land have been meeting the needs of humans since time immemorial. While depending on these resources, somewhere in the history, humans have crossed the capacity of natural regeneration. Increasing rates of consumption led to faster depletion of resources. Even there is human interference in natural recycling processes affecting the continuous availability of resources.

It can be seen that while in the past high productivity was being achieved, simultaneously the health of the soil is being sacrificed to achieve only a marginal and a short-term increase in productivity through mono-cropping, chemical fertilization and the use of chemical pesticides. Chemical-based agriculture has now reached its limits. Farmers in many parts of the world are giving up chemical farming and returning to traditional organic agriculture.

11.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The aims of gree revolution are : (a) Increase in foodgrain production (b) Increase in land productivity and (c) Increase in farmer's income.

2. The most important inputs of green revolution are : (a) Synthetic fertilisers and pesticides (b) Hybrid seeds and (c) Modern irrigation.

3. The major negative consequences of green revolution are : (a) Fall in per capita nutritional levels of food (b) Monoculture (c) Cash crop syndrome (d) Export orientation and (e) Chemicalisation of soils.

4. Rachel Carson's "The Silent Spring".

5. The environmental effects of modern irrigation systems are : (a) Soil salinity (b) Water logging (c) Displacement of people, especially tribals and (d) Deforestation.

11.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. What is Green Revolution? Write briefly about it.
2. Briefly write about Land and Water management.
3. Write briefly about traditional agriculture.

II. Answer the following questions in about 10 lines each.

1. Write briefly about monoculture.
2. What are cash crops? Write briefly about them.
3. What are the effects of chemical fertilizers and pesticides?
4. What is subsidy? Write briefly about subsidies to farmers.
5. Write a brief account on emerging farming methods.

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D. Narasimha Reddy

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BLOCK - 4
CHALLENGES-II

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UNIT-12 : URBANISATION

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12.1. OBJECTIVES

After going through this unit, you will be able to :

* list out the reasons for the migration of people into cities,
* list out the measures to be taken for mass transportation,
* explain the reasons for resource degradation,
* suggest the measures for pollution control in Hyderabad.

12.2. INTRODUCTION

Hyderabad is one of the fastest growing cities - its population estimated at 2.2 million in 1981 has reached 5 million in 1992. This was the result of a host of changes in the socio-economic policies of the governments. With the national economy gradually shifting from predominantly agriculture based to industrial, the resultant socio-economic factors necessitated people to shift from rural areas to urban areas. Also, successive industrial policies favored a 'clustered' approach to industrialization, further strengthening these factors. Country-wide, cities like Calcutta, Bombay, Delhi, Madras and Bangalore, in that order, took the brunt of this demographic shift until the mid-80s. But overall this growth rate has been slowing down due to varied factors such as deteriorating infrastructure, environmental degradation, inner city decay, costly living conditions and neighborhood collapse. In contrast to this trend, Hyderabad has become the new boom city in the past decade.

Founded by Mohammed Quli Qutub Shah on the southern banks of the Musi river, Hyderabad was a model habitat in its heyday. All its seven rulers, before Independence, were learned men and great builders. The city was noted for its mosques and minarets, bazaars and bridges, hills, lakes and baghs and roads. In the early 1900s, Nawab Mir Osman Ali Khan gave the city a modern water supply by constructing the Osmansagar reservoir. He also laid the foundations of a drainage system. But, presently, Hyderabad lost its old world charm and beauty. In any city's history, a 400 year stint is a major milestone; Cuttack celebrated 10001st year with pomp and style, and even earlier Calcutta remembered its age upon turning 301.

Hyderabad is said to be a cosmopolitan city with its population as varied as Indian population. Equally, its problems are as varied. This, as usual, basically, arises out of lack of planning, piece-meal approach, confusion of objectives, etc.. Once known as a city of 'baghs', how did Hyderabad come to this state of affairs? What are the responsible factors, both intrinsic and extrinsic? It is high time to diagnose its present status, which might help in charting a better future course for this erstwhile 'pride of the Deccan'.

12.3. STATE OF HYDERABAD

Hyderabad is one of the fastest growing cities in India, with growth rate exceeding 5 percent. In Andhra Pradesh, other cities like Vishakapatnam, Vijaywada, Tirupathi, etc.. do not matched this growth. Then what is so attractive in Hyderabad which draws people from even neighboring states of Maharashtra and Karnataka, apart from the districts of the State?

There are several factors which necessitate such a migration; categorized as 'push' and 'pull' factors. Push factors are those which induce migration leaving the people no choice, but to emigrate to Hyderabad. These factors further fall into different aspects: social, political and economic.

Politically, after Independence, India adopted a system of constitutional democracy. Over years, in this three-tier system, legislative and local governments and panchayats, the last two have been successfully marginalised. All powers are concentrated in capitals, state and central. In the social psychology, people gradually became accustomed to looking towards Hyderabad. With every decision being referred to Hyderabad, a whole army of middlemen developed. Migration due to politics of propagation was a general phenomena for the entire state. In Telangana, naxalite activities against big landholders, initially, and general violence by them has created unconducive atmosphere for peaceful living for particular sections of society in hinterland areas. Since urban areas conceal the identity and status, decreasing the 'targetability' of particular persons, migration from Telangana areas was maximum, continues to be so even now - there are other factors even.

12.3.1. Migration

It is generally a common notion that poverty forces people to migrate to cities in search of better employment opportunities. This is true. But it is largely unknown that even affluence is an equally strong reason for migration to cities. In coastal Andhra, where agriculture dominates the economy, affluence provides better educational opportunities for the farmers children who tend to look at agriculture not as a profitable activity, but a back breaking exercise. With social change, choice of professions are also changing. Affluence enables people to become doctors, engineers, etc.. which earns them money and a social status.

However, poverty continues to be the main factor for rural-urban migration. This situation is accentuated by drought, floods, and vagaries of climate. All these three arise out of mismanagement of natural resources - over exploitation without regeneration. Drought is a situation where there is

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no water availability for any biological life on a continuous basis. Deforestation and soil erosion had combinedly undermined the capacities of minor, medium and major irrigation projects. As a response, farmers in order to meet crop needs, resorted to heavy groundwater withdrawal. All these ecological changes disturbed the hydro-geological cycle in several areas of Rayalaseema and Telangana regions. Cyclones and floods became the scourge of coastal areas. Natural disasters on a continuous basis weaken the resolve to live in these areas. Thus, poverty and affluence, illiteracy and education and degradation and nature, lack of opportunity, all cause urbanization.

12.3.2. Hyderabad - Unscientific 'Science' City

Annual phenomena of cyclones in coastal areas, continuous 'dry' conditions in Rayalaseema and parts of Telangana, social upheavals in the Telangana region, planned economy in which 'centralization' is the key word, disparity in rural and urban commodity prices, and decimation of local self-governments have helped in the rapid growth of Hyderabad. Though Vishakapatnam and Vijaywada are also part of this phenomena, their growth rate is not on par with that of Hyderabad. Besides 'push' factors, this city has several 'pull' factors. Firstly, it is the seat of power structure. Secondly, it houses several industrial areas like Nacharam, Jeedimetla, Ramanthapuram, Balanagar, Azamabad, Katedan, Moulali, Uppal, Cherlapalli, Patancheru, Bollaram and Saroornagar. Thirdly, it has become an important centre for national research organizations and institutes like CCMB, IICT, NGRI, NIN, NRSA, DRDO, DMRL, DLRL, National Police Academy, National Institute of Rural Development etc. It also has several agricultural research institutions the biggest of them being the International Crop Research Institute for Semi-Arid Tropics (ICRISAT), apart from the Agricultural university. Also, it has as many as six universities. Thus, Hyderabad 'attracts' all sections of the society, and the unlimited scope for employment, real or perceived, has a magnetic effect.

This population shift resulted in enormous pressure for shelter and services fraying the fabric of Hyderabadi culture. Growth of Hyderabad, uncontrolled as it is, preceded the establishment of a solid, diversified economic base to support the build up of housing, infrastructure and employment. This haphazard growth had its consequential effects on the communities, and the community values. Law and order is the first casualty. Many of the problems are linked to inappropriate patterns of industrial development and the disjointedness between strategies for agricultural and urban development.

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12.3.3. Mass Transportation

Traffic congestion, housing, road conditions, pollution, unemployment, crime and violence: all of them are interrelated as if there is a network of problems, balancing and perpetuating each other. There is as yet no study to identify the reasons for traffic congestion, and the necessary mitigation measures. But, generally, the failure of mass transporting units like buses and trains in easing the problem owing to different factors had led to the above mentioned problems.

As an alternative, a Light Rail Transit system has been proposed to be setup in the busiest traffic corridor from Kukatpally to Charminar. However, if reasons for traffic congestion are not studied, LRTS may well be the additional cause for traffic chaos. Considering the magnitude of LRTS project, it is unlikely to be completed within 10 years, and possibly more. Project overruns, while increasing the costs, will put tremendous pressure on already congested road conditions. Calcutta Metro project after more than a decade with several cost overruns extends only to 10 Kms, as also the Madras MRTS project. Thus it can be easily understood that any of the city's problems cannot be approached in isolation. Unless, each problem is analyzed to establish the contributing factors and identify the common factors which cause these problems, any project is not going to solve the problems.

Check Your Progress - 1 & 2

1. List out different environmental problems faced by Hyderabad.

2. Which major industrial location rendered the city of Hyderabad the most polluted?

Note : (a) Write the answers in the space given below.

(b) Compare your answers with those given at the end of this unit.

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12.4. RESOURCE DEGRADATION

Haphazard growth of Hyderabad has degraded natural resources like water, air, and soil. Environmental pollution has reached alarming levels in the last 5-6 years. This has been chiefly due to industries and automobiles.

Effluents of several bulk drug industries are stored in open pits. This led to extensive ground water pollution affecting the sources of agricultural and drinking water needs of the surrounding colonies. Environmental conditions in Ramanthapur and Uppal areas continue to be the cause of concern due to some small-scale pharmaceutical industries, and multinational companies. Most of the industries are in the midst of residential areas, with no proper drainage system and without any effective monitoring of the industrial discharges.

Nacharam is another typical example where you find a industry besides human habitat. This area includes industries like Liquors India, United Breweries, Deccan Nitrates, Hyderabad Chemicals and Fertilizers. A bone-meal factory, which was a continuous source of obnoxious smell and foul air, was shifted out owing to public pressure. Only one industry, M/s. Laxmi Starch Ltd., has installed pollution control equipment which can be welcome sign if used properly. There was a proposal to lay a pipeline to carry effluents of all the industries in Nacharam to Amberpet to be let out into River Musi. Effluents of Deccan Nitrates and Nuclear Fuel Complex are most hazardous. Presently, the ground water in an area of 100 sq.km. is polluted by nitric acid. NFC uses extremely sophisticated metallurgical technology. It has a ambitious five-fold expansion programme. However, usage of hazardous chemicals on a large scale both in transport, storage and manufacturing processes

in the midst of residential areas has potential ramifications which have been generally ignored by everybody. Hazardous industries cannot be established within 100 Km of any residential area.

Modern industrial development, particularly of the chemical industries in Hyderabad started with the location of Indian Drugs and Pharmaceuticals at Balanagar. Though not recognized then, its location has been the source of all problems of pollution in Hyderabad - it is located in the catchment area of Hussainsagar and in the windward direction of Hyderabad. A host of industries developed on the upstream of all water channels of Hyderabad, thus, subjecting the residents to numerous problems. Establishment of IDPL resulted in the proliferation of chemical and pharmaceutical industries in Jeedimetla, Kukatpally and surrounding areas. Due to a vacuum in the Town planning policy, industries and residential areas developed alongside each other. In the process, prime agricultural land and a series of percolation tanks upstream of Hussainsagar were obliterated.

Jeedimetla supposed to be India's biggest small scale industrial area is virtually a gas chamber. Solid wastes can be seen dumped everywhere, industrial effluents take gravitational course and end up in road side pits and the ambient air is befouled by a variety of pollutants. Air pollution is rampant in the industrial zones caused by boilers, process fumes and automobiles. Ground water pollution is extensive, accidents are frequent while the effect on human health is continuous and maximum. After considerable public pressure, a common effluent treatment plant was established. But this might not be the complete answer to the pollution problems in this area.

Azamabad industrial area finds itself among the residential areas of Ramnagar, Vidyanagar, Musheerabad and Baghlingampally, despite being on the outskirts of Hyderabad 40 years back. At present, the only option is shift out the industries in this area. Presence of these industries is a continuous health hazard to the surrounding residents. Katedan industrial area poses the same problem as Jeedimetla and Azamabad, and more. It lacks many infrastructural facilities with most of the industries belonging to small scale sector. Though situated in Medak and Ranga Reddy districts, industrial area of Patancheru, Bollarum and Cherlapally are nearer to Hyderabad due to territorial proximity. There are many highly polluting industries in Patancheru and Bollarum, which lack even minimum pollution treatment facilities. Almost 25 villages are affected by the industrial pollution. Crops are damaged, land is degraded, general health of population has declined sharply and cattle are dying in numbers. Cherlapalli is another area of concern for environmentalists.

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12.4.1. Hussainsagar Lake

Hussainsagar is a 400 year old lake connecting the twin cities of Hyderabad and Secunderabad. It was originally built to serve the purpose of public water supply and irrigation. Irrigation was abandoned when urbanization took place early in this century and since the 1930's the lake is no longer used for public water supply, due to inadequate yield and heavy pollution. The total catchment area of the lake is 240.56 sq.kms while the lake surface area is estimated to be 6.50 sq.kms. It receives inflows from the following streams; Kukatpally nala, Yousufguda stream, Banjara hill nala, Balkapur channel and Picket nala.

The glory of the lake ended the day industries came up in the catchment area. Industrial estates were established in Jeedimetla, Balanagar, Sanathnagar and Kukatpally, which fall in the catchment zone of the lake. Due to haphazard industrialization, unplanned growth and gross negligence, Hussainsagar is now a toxic reservoir. Gradually, Hussainsagar became a reservoir of industrial effluents and sewage. About 25 years ago, an industrial pipeline known as Kukatpally Main (K-Main) was laid for the purpose of transferring industrial effluents to the downstream of the lake. Poor maintenance of this pipeline did not serve the purpose it was intended for - it is broken at several places. Over years the pipeline got corroded and developed huge leaking points.

Thus, the K-Main and the purpose became redundant. Added to this situation, government permitted at one time industries in Patancheru to dump their effluents into K-Main for considerable period.

Table12.1. Hussainsagar Lake - Water Pollution Control
(By Osmania University - January, 1986)

S.No.	Parameter	Concentration	Standards
1.	Temperature	25.43 C	-NA-
2.	PH	8.34	-NA-
3.	Carbonate	33.54 mg/l	-NA-
4.	Bicarbonates	320.33	-NA-
5.	Chlorides	166.27	-NA-
6.	Oxidizable O.M	7.75	-NA-
7.	Dissolved oxygen	3.62	-NA-
8.	Sulfate	91.39	-NA-
9.	Sulfide	88.02	2 mg/l
10.	Total Hard	145.84	-NA-
11.	Calcium Hard	66.39	-NA-
12.	Magnesium Hard	79.44	-NA-
13.	Cal++	42.43	-NA-
14.	Mg++	19.32	-NA-
Nutrients			
15.	Orthophosphate	0.482 mg/l	-NA-
16.	Nitrates	10.60	-NA-
17.	Nitrites	0.036	-NA-
18.	Ammonia	0.260	-NA-
Heavy Metals			
19.	Iron	1.97 mg/l	3.0 mg/l
20.	Zinc	186.00	5.0 mg/l
21.	Chromium	72.33	2.0 mg/l
22.	Lead	41.10	0.1 mg/l
23.	Copper	26.83	3.0 mg/l
24.	Cadmium	4.60	2.0 mg/l
Heavy Metals in superficial sedimentation			
25.	Cadmium	4.27 (mg/kg dry)	2.0 mg/l
26.	Lead	47.73	0.1 mg/l
27.	Nickel	62.39	3.0 mg/l
28.	Chromium	100.34	2.0 mg/l
29.	Copper	167.60	3.0 mg/l
30.	Zinc	412.65	5.0 mg/l
31.	Manganese	1200.00	1.0 mg/l

Average results over one year of sampling (Mixed results of surface, middle and bottom)

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Most of these upstream industries are chemical related and generally lack pollution treatment facilities. Dangerous chemical effluents are let into the streams that feed the lake. Solid wastes are washed into the streams during the rains. There are now tons of toxics deposited in the lake. Industrial inflows into the lake through Kukatpally nala are estimated to be 9540 CMD.

On a daily average, 18,650 CMD of sewer water join Hussainsagar from all the channels. The average population density of phytoplankton is estimated at 5.40 x 10.7 organisms/litre. Total species identified are 110. Blue green algae dominates other algal groups.

It has become the dead water body unfit for any recreational purposes like swimming or boating. Studies have shown that fish have got a very high content of heavy metals in their body especially in their brain.

In addition, the annual ritual of Ganesh Nimmajjanam (Immersion of Ganesh Idols) is done on a massive scale. Some thousands of idols are immersed, which are made from different materials, with paints et al. Thus, the mercury levels in Hussainsagar in 1986 were 152 mg per Kg of sediment and 16 mg/l of water. Apart from the mercurial pollution, the immersion of idols add to the sedimentation of the lake decreasing its storage capacity. Visibility under the water is now barely 6 cm. The lake itself has been shrinking owing to illegal occupations along its bed, and road construction. Two roads, Buddha Purnima Road and Necklace Road and Lumbini Park today stand on the lake bed. The Necklace Road, presently, is under construction. This lake is still the site for washing clothes, bathing, resting place for buffaloes and a popular spot for people to relax. Ground water in down stream areas is absolutely polluted though studies have not been done to analyze them.

Flows from Hussainsagar join River Musi. Fodder plots along this river bed cater to the needs of the milch animals. This link confirms the pollution of food chain itself. Even the beds of streams which feed the lake have these fodder plots. So far, a dozen studies have been made on this lake. There were a few initiatives from France and Australia to restore the lake. A comprehensive plan is supposed to have been chalked out, though nothing is in concrete shape.

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Some of the options contemplated are :

(a) To direct Kukatpally and Picket nalas to downstream of Hussainsagar.

(b) To release pre-treated industrial effluents from industrial areas through common effluent treatment plants.

(c) To decrease the size of the idols immersed in the lake.

(d) To insulate the lake from encroachments through construction of Necklace road.

(e) To dredge the lake with water or without water.

Some have been attempted, but have failed to take-off.

12.4.2. Garbage Disposal - Time to Turn the Page

Bordering the Deer Park, on the outskirts of Hyderabad, an yesteryear hunting ground of Nizam rulers, the Municipal Corporation has created a 12 acre Central Garbage Dump Yard. People

visiting the Deer Park, along with pure air, get a gust of air conveying the smell of garbage. Once situated at Amberpet, this dump yard was shifted to Vanasthalipuram. This yard offers a diversity in garbage composition - from the stiffened bodies of dogs (tens of them), large intestines of animals (or of humans we cannot judge), hospital waste, hotel leftovers to household 'throwaway' - we can find everything that a society can reject. Unbearable stench spreads for kilometers around. Nobody can endure the smell beyond a minute. All sorts of scavengers can be found here from vultures, crows, pigs, dogs and even rag pickers: all do their best in garbage management. A single shredder machine stands idle - a mute reflection of the mute response of the communal services. Scavengers are doing their best in performing their role in the nature's cycle of resources usage i.e., recycling. But the increasing piles of garbage is beyond their capabilities, despite vast numbers. Slaughter house waste can be seen everywhere. Residents of the nearby government employees colony are regularly showered with the samples of the same by the ever intruding crows. The atmosphere is malignant, and an ideal setting for breeding of bacteria and virus. An American anthropologist, recently said that garbage disposal sites offer the best source material for anthropological studies. Whether it is a proper source or not in America, but surely the Vanasthalipuram dump yard is best suited for behavioral studies on twin cities residents. There are many such places around Hyderabad.

Everyday, tons of garbage is produced in the twin cities. However, the whole process, of garbage disposal, is governed by apathy, irresponsibility, unaccountability and non chalance. Frequent shifting of garbage dumping sites, or centralizing the collection, does not meet the growing garbage crises. There is a need for a different outlook. Government has to formulate a procedure wherein the garbage collected is put to some productive usage. This needs imagination, a goal, a strategy and a policy. It is worth mentioning here that, in the United States, a separate discipline on garbage has been developed, which is called Garbology. Even they have a museum on Garbage. Mainly garbage comes in four forms: 1.) Dry elements like plastics, glass etc., 2.) Natural waste of fruits, vegetables etc., 3.) Waste papers and 4.) 'establishment' wastes, from hospitals and hotels.

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With the spurt in urbanization and change in life styles, composition of garbage has also changed. As the density of population has increased, which brought in its wake a rise in garbage quantity. Increasingly, the municipal authorities are unable to perform their old job of collecting the garbage and disposing it by burning at a central place. Modern day consumerism has also changed the composition of the garbage. This calls for a new approach and new methods to tackle the growing problem of garbage disposal. It needs a new line of thinking. Under this, an integrative method should be followed which monitors the movement of the garbage right from its source to the end-use. The goal of the whole approach should be the recycling of wastes. Unless recycling is done, in this age of consumerism, soon we will face the problem of resource depletion and high mountains of garbage. Tokyo is unable to find a place to dump their garbage generated daily at the rate of an area double the size of Lal Bahadur Stadium. In United States, land digging often yields old newspapers and other 'vintage' garbage, rather than iron-ore or gold. The strategy of the new garbage clearance approach should be to involve the community. Public education is a must. Education need not be limited to advises to keep the surroundings clean, but a comprehensive philosophy which forces a citizen to participate in garbage management before he throws anything away. This education can serve its purpose only when the municipal authorities change their methods of garbage collection. Following the various forms of garbage, it needs to be classified at the source itself.

Presently, all types of garbage are lampooned at a single point, which is squeezed into a small hold by the 'Pneumatic Machines' of garbage carrying vehicles. Thus, more often the 'wet' part of the garbage is left behind which is the actual source of bad smell and unhealthy atmosphere. As in

Western countries, each form of garbage has to be separated at the sources - households, hotels, business establishment etc., - by collecting them in different containers. This makes it easier for the municipal staff to collect the waste at the source premises, instead being thrown at street-ends. Consequently, recycling of the garbage becomes easier. Dry 'throwaway' like bottles, plastics etc., can be sent to the industries concerned for re-use. Bio-degradable waste can be used either for cooking purposes (methane gas) or for electricity generation. Faced with the frequent energy crisis, large metropolitan cities have to be self reliant in energy production to avoid black outs. Paper waste should be necessarily recycled. With depleting forests and balance of payment problems, in the near future, there would be a severe paper shortage. Though there is a large force of rag pickers, their efforts can be maximized by streamlining the whole process of garbage disposal. All the green litter, such as leaves, degraded fruits, leftover food, should be processed for manufacturing natural fertilizer. Urban areas can contribute to the rural food production atleast in this way.

12.4.3. Automobile pollution

Automobile density has increased tremendously in the past five years along with the unplanned growth of the city. In addition to public transport and surpassing its growth rate, every other type of personalized vehicle number rose sharply. Linear growth along the main roads is one of the major factors for this exponential increase in automobiles. Estimates show that there are nearly 6 lakhs of different categories of vehicles out of which nearly four lakhs are two wheelers and one lakh cars. On an average daily 11 lakh liters of petrol is consumed. If the diesel consumption of other vehicles is added to the above, it is beyond one's imagination as to how much amount of carbon monoxide, nitrogen dioxide, ozone (indirectly), lead and monocarbons are released into the atmosphere due to this consumption. Narrow roads, while reducing the traffic speed, cause more emissions due to idling of the engine. Of these emissions, carbon monoxide is the most hazardous. Most of the respiratory and heart diseases can safely be attributed to this foul urban air. The most vulnerable sections are: children, the elderly, asthma patients, police men, road side vendors, mechanics, etc. The Pollution Control Board and the recently amended Motor Vehicles Act had failed to check this urban menace. Noise pollution is more insidious than easily recognized air and water pollution and is invisibly undermining the physical and psychological well being of millions of people. Noise affects rational thinking of human being, as it is stressful on the nervous system. In Hyderabad, lesser attention is paid to sources of noise pollution and as such are not curbed.

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12.4.4. Drinking Water Sources

Hyderabad faces water shortage, very frequently. This situation arises despite three phases of Singur project. Reasons for such a situation are not limited merely to industrial and urban growth. They include lack of coherent water policy and neglect of sources like River Musi, Hussein sagar, Osmansagar, Mir Alam Tank and various other lessen-known tanks.

Hyderabad is perched on the Deccan plateau, 1776 feet above the sea level. Realizing this limitation, previously, a series of tanks were created in and around the city to augment rain water and other water sources. Hussainsagar was dug during the time of Ibrahim Quli Qutab Shah by Hussein Shah Wali in 1562, to meet the drinking water needs of the residents. Now it is nothing but a pool of industrial effluents and solid wastage. Most of the other upstream tanks have been reclaimed by zealous real estate developers, some are in the process of being reclaimed and the remaining few serve as cess pools of sewage. Mir Ali tank which serves most of the old city water needs is in the

process of becoming extinct due to land grabbers. Some houses are built on the upstream of this lake. This is alarming, considering that raw domestic sewage from these houses is let directly into the tank, which serves the drinking water needs of residents in old city. Trucks are washed here, thus contaminating the water with oil and grease.

River Musi is another neglected water resource. Its existence itself is threatened not solely from private interests but from the government also. A bus complex was constructed in the midst of the river opposite Gowliguda - the place is called as Imbliban. Initially, government announced its intention of restricting itself to the natural island, but lateron lot of land filling was done. Within a few years, the river may not be visible at all. The river hardly receives any fresh water except city sewerage. In the catchment area of this river, near Vikarabad, government has allotted pattas for agriculture purposes against all norms of watershed management.

12.4.5. Monuments

Charminar, the pride of Hyderabad and the official logo of Hyderabad 400 celebrations, is the epitome of neglect. Daily hundreds of vehicles with internal combustion engines pass around this historical monument. Pollutants like carbon dioxide, nitrogen dioxide, peroxy acetyl nitrates (PAN), and vibrations due to heavy vehicle movement have combinedly damaged the beautiful edifice of Charminar. Rain water, after mixing with the air pollutants has damaged the surface of Charminar beyond repair. There is a need to ban immediately all vehicular traffic around it, construct a park leaving enough space for cycles and rickshaws to pass through. Only this radical step can check deterioration of Charminar. Places of historical significance like Golconda Fort, Falaknuma Palace, Chiran Palace, Mir Alam tank, Osmansagar and Hussainsagar have to be declared as national monuments. Urgent steps need to be initiated to restore and develop these ares in the larger public interest.

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Hyderabad, with its fast growth, is rapidly becoming an unhealthy place in all its aspects. Services like housing, education, medical facilities are not available on the basis of need, but only on the basis of money. Thus, these services are spawning a different culture which thrives on corruption and criminal intentions. Real estate business has befuddled the already beleaguered administration of the Municipal Corporation of Hyderabad. Impact of urban blight can be seen more upon children than anyone else. They are the most vulnerable section vis-a-vis pollution, socio-cultural changes and value shifts. Urban children, belonging to all sections of society, suffer from problems ranging from diseases to destituteness. Neighborhood schools is the answer for many of these problems.

Check Your Progress - 3, 4, 5 & 6

3. Name the industrial areas which are the most polluting, and explain the alternatives available briefly?

4. List out the factors which have decimated the Hussainsagar lake.

5. What is the impact of urbanization on the population of Hyderabad?

6. Which major project is being projected as the ultimate solution to the drinking water shortage in Hyderabad?

Note : (a) Write the answers in the space given below.

(b) Compare your answers with those given at the end of this unit.

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12.5. RESPONSES : ADMINISTRATION NON-RESPONSE

Most of the administrative actions are disjointed and fragmented. There is a wide public gap in the management, planning or foresight. Its actions are based on outright political considerations or deficit data. The concept of town planning has been long back forgotten. The A.P. Pollution Control Board is bogged down by political interference and administrative inefficiency to be bothered about pollution - industrial or automobile. The Road Transport Authority and traffic police are not in any way equipped to check pollution. It is highly imperative that a Regional Environment Protection Authority is constituted to manage the entire gamut of problems arising, basically, out of haphazard growth. Municipal Corporation of Hyderabad has to be restored to its status of local self government with a jurisdiction ranging over a radius of 50 Km at the least. It has to generate its own funds and should be allowed elbow room to manage all urban affairs of Hyderabad.

Social response : Despite many problems, community response has been minimal. In this situation, Citizens Against Pollution (CAP), was formed in 1985. Since its inception the CAP has pioneered several movements in Saroornagar, Nacharam, Jeedimetla, Patancheru and Katedan. Over years, the CAP has highlighted several problems of Hyderabad and has been at the forc front of environment struggles. This is one action group which serves on commitment and voluntary effort, rather than on any funds. Consequently, many other groups have been formed in many areas. This is a positive indication of citizen action in response to the problems faced by them. But, still, there is a lot more potential to be tapped. Though there are many scientists, educators and administrators of high caliber, it is truly unfortunate that not many of them are really helpful in solving environmental problems of Hyderabad. This probably could be explained by the fact that most of them are outsiders to this city and as such lack any feeling of attachment towards it. There is a need for more citizen involvement to restore the old charm of Hyderabad.

12.6. INITIATIVES FOR PROBLEM SOLVING

1. Improvement of all infrastructural facilities like roads, electricity, drainage systems in industrial areas.

2. Establishment of primary pollution treatment facilities is the need and individual industries should be persuaded by all means to do so as early as possible.

3. Separate environmental courts should be set up.

4. The Andhra Pradesh Pollution Control Board should be reconstituted to give a wider representational base to its organizational structure by including environmental activists also, to achieve a better response towards environmental degradation.

5. Cycle and mass transportation are the twin answers for many urban ills, in Hyderabad.

6. Two separate parallel water lines should be laid. One for drinking water and the other for non-potable water. Drinking water pipeline needs to be made of sturdy non-corrosive material. This provision enables water supply authorities to deal efficiently with the needs and contingencies in a better way.

7. Existing parks and open spaces should be declared as community property in order to prevent encroachment. While these places serve as rain water percolation points for ground water recharge, government itself is guilty of misutilizing them - construction of Telugu University in the Public Gardens is one such example. Bagh Lingampally, once a tamarind grove is full of concrete structures. Unless the existing lung spaces are preserved and provide for more, Hyderabad will continue to be under the grip of carbon monoxide and other pollutants.

8. The problem of solid waste can be reduced by promoting reuse, recycling or reclamation of materials, stimulate employment and result in savings of raw materials. Composting of bio-degradable land waste can support agriculture.

   Since the MCH lacks the resource to collect house hold and other wastes regularly, it can support community based schemes. The MCH and government have to recognize the potential of the informal sector in garbage management and should include them in all of their waste disposal schemes.

9. Financial institutions and government should encourage community-based ground water pumping systems rather than finance individual households. In a given area, indiscriminate bore well digging means quick drying of ground water resource. A community based bore well system while saving on investment also eliminates the possibility of indiscriminate use of water.

10. Tank bund should be closed for all vehicular movement. For the residents of Hyderabad, the only relief can be in parks, Nawbhat Pahad and tank bund. As a plausible solution, this ban should be on Saturdays and Sundays and during morning and evening on all days.

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11. Suburbs and fringe areas should be developed to be more attractive and livable particularly of four national highways touching Hyderabad in all aspects like augmenting the road network and transport facilities, establishment of retail market centers, schools, hospitals, hotels and other infrastructural facilities. This would relieve pressure on the dense inner-city area. Modern communication systems can provide further incentives.

12. Proper zoning system of residential, industrial and commercial area needs to be followed strictly.

13. Government should promote research studies on problems of Hyderabad to bring out causes which can help in chalking out specific and time bound schemes. All universities and research institutions can take up a comprehensive project with each institution concentrating on a particular aspect.

14. Hazardous industries like Nuclear Fuel Complex have to be shifted out of the city.

15. All tanks, in and around Hyderabad (especially, Hussainsagar), have to be insulated from garbage, sewage and encroachment. They should be developed as entertainment centers.

16. River Musi has to be preserved for ecological reasons, as also for historical and aesthetic reasons. Government should immediately constitute a separate authority for all river basins in the State, and in that context, particularly, for River Musi covering its entire stretch, from catchment area to the drainage basin.

17. Citizens involvement and community participation is a must to evolve norms, codes or procedures to curb noise pollution. As a first step, vulnerable areas like hospitals, schools and religious places have to be identified.

18. Neighborhood schools can be the modern version rallying point of the communities of erstwhile village centers where all information is shared, problems discussed and acceptable solutions are arrived at. These schools by their very concept, transcend all barriers - language, caste, creed, religious and economic. This concept can be the basis for urban villages within the city.

19. Vertical growth of the city, on the face of it, looks inevitable. But in this modern era of sophisticated communication facilities like computers, telecommunications, it need not be inevitable. Development of satellite townships and segregation of industrial, residential and commercial activities equipped with modern facilities can rid urbanites of the drudgery of apartment living.

12.7. SUMMARY

Urbanization is inevitably linked with modern development, and as such is viewed by many as a necessary burden to carry. In fact, some see it as a indicator for a scientific approach to human life, away from the rigid framework of traditional beliefs and customs. It is considered as an ideal place to live a independent life, offering enormous freedom to liberate one's mind. Even if this thinking is worthwhile, the daily drudgery of urban life in comparison is generally glossed over. If one studies the urban problems one cannot but conclude that in the name of development modern human being has spawned a urban culture which at once strikes at the basic roots of existence and survival, though not direct always. Thus, for example, though one attains the freedom, the urban resident is also prone to danger from a variety of hazards, and for which there is no protection either from the community, nor from the science and technology. This situation is further complicated by the institutional structure in Third World countries, corruption, political and social values, and citizen behavior.

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The case study of Hyderabad is chosen to highlight the other side of modern development and the consequent urbanization. Most of its problems are beyond the regular mitigation measures - each problem has umpteen knots testing the patience of even diehard officials and citizens alike. Further reading on urbanization in general is suggested to sharpen the points raised in this chapter.

12.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Industrial pollution, automobile pollution, traffic congestion, drinking water shortage, housing problems, garbage disposal, transportation, rise in ambient temperatures, inadequacy of mass transportation, congested roads, deterioration in socio-economic and cultural standards, institutional incapacitation, dense population, resource degradation, etc..

2. Jeedimetla-Sanathnagar-Balanagar areas rendered the city of Hyderabad the most polluted.

3. Jeedimetla, Katedan, Nacharam, Balanagar, Ramanthapur and Patancheru. Effluent Treatment plants at individual industries, recycling mechanisms, and recovery.

4. Industrial effluents, encroachment, domestic sewage, garbage, apathy of government and people.

5. Deterioration of health, shifts in the disease pattern, socio-cultural changes, ethics and social values.

6. Water project which envisages pumping of water from Nagarjuanasagar Reservoir, from a distance of 140 kms and at an estimated cost of Rs.600 crores.

12.9. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. What are the reasons for the migration of people into the cities? Briefly write about this.
2. Hyderabad is considered to be a unscientific science city - Explain.
3. Hussainsagar is considered to be a highly polluted lake Why?
4. Suggest the methods for the disposal of garbage in twin cities.

II. Answer the following questions in about 10 lines each.

1. What are the reasons for the pollution in Nacharam area?
2. Write briefly about automobile pollution in twin cities.
3. Write briefly about drinking water sources for twin cities.
4. What measures do you suggest for the protection of Charminar?

D. Narasimha Reddy

BRAOU

UNIT-13 : INDUSTRIALISATION

Contents

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13.1. OBJECTIVES

After going through this unit, you will be able to :

* educate the people about environmental laws and people's assertiveness,
* describe the role of different social factors in the struggle for equity and social justice,
* explain the legal provisions and the dichotomy between modern development and sustainable development.

13.2. INTRODUCTION

Issues of environment, intertwined with those of economic growth, equity and welfare, arise mostly out of the pattern of 'development' followed. Industrial pollution, a spin-off of rapid industrialization and modern development, has wrought havoc in many areas condemning thousands to live a life of ill-health and poverty. Currently, the problem of industrial waste management challenges us, as a society, to take as much care for present and succeeding generations as for those into the distant future. It is increasingly becoming clear that the sources and causes of industrial pollution are far more diffuse, complex and interrelated, and the effects of pollution more widespread, cumulative and chronic. The challenges are both interdependent and integrated, requiring comprehensive approaches and popular participation.

In the past, industrial and economic growth was helped by abundant resources, obtained either domestically or from elsewhere. Today it is not the same. It was also usually assumed that science and technology were inherently good and contributed to progress. However, as experience shows, large scale technologies also have accelerated the concentration of economic and social power and have proved difficult to control. Early in the 1970s people became aware of environmental degradation though they were still confident that technology could overcome resource constraints. But by 1980s escalating environmental and human costs of technological solutions were evident. Expanding industries consumed raw materials and generated wastes at unprecedented rates. Presently, each and every nation is plagued by some form of environment pollution but issues differ.

In India the situation is no different. Almost all the States have the common set of environment problems with variations in degree. Given the socio-economic disparities, these problems mostly put the poorer sections of the society at disadvantage. Though this aspect has not been elaborated in this chapter, it typifies it.

Andhra Pradesh is one of the five big States in India. With three distinct natural regions, it houses a large variety of natural resources. Prior to 1980s, its economy was considered to be predominantly agriculture based. In the past two decades, the State has continuously and deliberately tried to move away from the agricultural economy. From a modest beginning during independence with only 45 large and medium industries with an investment of Rs 63 crores this state has emerged as one of the major industrialized states in the country. At present, it has 828 large and medium industries with a total investment of Rs.11,772 crores providing employment to nearly five lakh persons. This pace of industrialization was particularly rapid in the past decade. However, industrialization tended to be clustered in the capital city and one or two other centers, with concomitant socio-economic problems.

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13.3. INDUSTRIALISATION IN PATANCHERU

Located on the eastern side of Hyderabad, on the National Highway, in Medak district, Patancheru is a small town the foundation for whose transformation was laid in 1962. An area of 56.26 acres was earmarked for industrial development. Starting with five phases, industries in Patancheru have mushroomed in the last decade. Beyond the identified industrial area, industrial units have been setup where ever around Patancheru and all along the Highway.

13.4. DESCRIPTION OF PATANCHERU & SURROUNDINGS

Patancheru is one of the industrial areas located in the surroundings of Hyderabad. In 1981, Patancheru was a small town with a population of 10,947 while the present estimates put the figure near about 50,000. Andhra Pradesh Industrial Infrastructure Corporation which was formed in 1973 developed the area in five phases. In all the five phases, presently, there are 276 industries and an additional 31 industries in and around Patancheru. Prior to all these, two big projects were established in 1967 and 1972: Bharat Heavy Electricals Limited at Ramachandrapuram and the International Crop Research Institute for Semi Arid Tropics (ICRISAT) nearby. The crop research institute was established to promote research on agricultural improvement techniques through international technology, man power and financial resources.

Products of this industrial area range from chemical, pharmaceutical, agrochemical, paper, paints, cellulose, steel to refinery, apart from a number of machine works. Employment generated by these industries is for about 12,500 persons.

Another industrial area is located near a village Bollarum in Jinnaram mandal of Medak district. This area is closer to Patancheru area. Certain area near Bollaram village was earmarked by the Andhra Pradesh State Non-Resident Indian Investment Corporation (ANRICH) to set up industries. Some of the other industries, not in the NRI category, have also come up in this area. Industries here are, predominantly, pharmaceutical units, and their products include bulk drugs like sulpha methoxazole, ibuprofen, trimethoprim and paracetamol. Totally, there are 53 industries.

Both the industrial areas lack proper infrastructural facilities like water supply, roads and sewer lines, which have not been developed properly. Much of the process water needs are met by individual borewells. Sewer lines are almost absent. Many units also depend on the tanker supply of water. Roads are improperly developed.

13.4.1. Geographical Location

Geographically, Patancheru town is situated at a place where, as geologists say, a massive quantitative potential of ground water exists. The general slope of the area is towards North-West and forms part of a microvalley of River Manjeera. In this micro-valley, Chinna vagu, Pamula vagu and Pedda vagu are some of the minor tributaries of Nakka vagu which ultimately joins River Manjeera at Gowdicherla - travelling a distance of 23 kms. There are two tanks on the northern side of Patancheru, and one Saki tank on the southern side.

Nakka vagu is the mainstay for about 15 to 20 villages, which serves drinking water and irrigation purposes. Starting from Gangaram, it touches Ramachandrapuram, Usikay Bavi, Pocharam, Bachugudem, Lakdaram, Byathole, Pedda Kanjerla, Chidruppa, Ismailkhanpet, etc.

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13.4.2. Socio-political Situation

Politically, this area has been a traditional base for the Congress party. Main occupation of the people is agriculture and paddy is the principal crop. Their lifestyle is typical of any Telangana area. Agriculture is dependent on the South-West monsoon and on tanks, dug-wells and Nakkavagu - maximum rainfall is only in the months of July, August and September for the whole year. As mentioned earlier, ground water potential is adequate in these parts.

13.5. IMPACT OF INDUSTRIALISATION

Effluents from the industrial area are drained by a southern water course which receives waste water from Phase II and a few other industries, while a northern water course receives water from Phase IV area. Ultimately, all effluents join Nakka vagu after allowing for seepage at various pits and drains. Discharges at Bollarum also are let out into the open, which join a irrigation tank, Asani kunta, by gravitation. The industrial area itself is situated in the catchment area of this tank. Basically, it is an irrigation cum percolation tank serving the agricultural needs of Sultanpur and Gandigudem villages and replenishing their ground water reserves.

An independent estimate puts the waste water flow in Patancheru at 5 million liters per day. And the waste water generation of 29 major polluting industries in Patancheru is 1642.9 cu m/day while the volume of consumption being 3041.2 cu m/day. In Bollarum, 24 major industries discharge effluents to the tune of 786 cu.m/day. Their daily water consumption is 1133.7 cu.m.

Qualitatively, the characteristics of these effluents are quite alarming. Some independent analyses show that various parameters, like chemical oxygen demand, suspended solids, total dissolved

solids, oil & grease and the bio-chemical oxygen demand are exceeding the suggested ranges for effluent discharges into surface waters, including irrigation waters, public sewers and oceans. Normal suggested range for pH is 5.6 to 9.2, but one effluent sample shows pH level as 1.1 while another one showed 12.9 - sample analysis information was available only for 45 industries. Effluents of one of the industries contains iron upto 11,000 mg/l and zinc upto 450 mg/l. Further, it was also found that in some cases, the chemical oxygen demand (COD) level reached as high as 5,15,000 - acceptance limit is well below 300.

In Bollarum, despite the number of industries being less and as such the volume of effluents is also less, the effluent characteristics are more scary. Against the suggested range of pH level from 5.6 to 9.2, one sample shows the level at 3 and another sample has pH level of 40. Other parameters exceed even the Patancheru figures.

Air pollution also poses hazards for public health in these two industrial areas, especially in Sultanpur village and Patancheru town. While epilepsy among the children and youth is more pronounced in Sultanpur, Patancheru population suffer from asthma and other lung related disease. In Bollarum, almost all the units are sources of air pollution. Solid waste dumps can be seen everywhere on roadsides, inside the industrial areas and outside, even along the National Highway No.9. No single industry has any facilities to treat or recycle its solid waste.

13.5.1. On Resources

Over days, crops and lands were degraded in villages such as Pocharam, Ganapathigudem, Inole, Lakdaram, Bachugudem, Pedda Kanjerla, Chitkul and Ismailkhanpet. With the contamination of ground water, availability of pure drinking water for villagers became a distant dream. After the effluents started exceeding the capacity of Asani kunta, its bund was deliberately breached by the industries in 1986. It resulted in the inundation of downstream agricultural fields, pollution of wells by the stream side, and contamination of Posamundram, a tank serving the needs of Kishtareddipet village. Consequently, ground water all along the Nakka vagu is polluted, and, at the surface level, the water flow constitutes nothing but effluents - it only gets diluted during rainy season.

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Misery caused by this high rate of pollution to human population has been widely reported in the news media. Villagers are suffering from alien diseases, like epilepsy, skin and throat problems, respiratory diseases, conjunctivitis, glaucoma, cancer, leukemia and paraplegia. NEERI report cites farmers as saying that pregnant women are delivering still-born children. Possibly, this means that even future generation has been affected, as germ plasma itself seems to have changed. Further, there is high rate of infant mortality. Cases have been reported about girls not attaining puberty at proper age and married women are not conceiving. In Sultanpur village alone, in 1989, there have been nearly 6 deaths due to cancer, and four more suffer from it.

13.5.2. On Economy

Estimates of damage due to pollution of natural resources of villages have not been comprehensive. Between 1984 and 1989, as per government's assessment, total land affected due to industrial effluents of Patancheru and Bollarum is 1382.28 acres. A 1991 estimate by the National Environmental Engineering Research Institute (NEERI), Nagpur, calculated the area to be 1,717 acres belonging to 581 farmers. Not to rely on official figures, action groups working in the area collected their own data and declared that the area damaged as 549.79 acres and the loss in monetary terms as Rs.1.32 crores by 1989. This excludes Rs.44 lakh losses incurred in terms of

damage to 150 pump sets, alongwith pipings and other fittings. This study annualized the equipment loss at Rs.1.89 lakhs per year for 15 years with 10 percent rate of discount. For this loss, by 1992 the compensation received by the villagers was a paltry Rs.7,46,521. There has been widespread cattle loss as they became vulnerable to drinking polluted waters in the streams and drains. However, no precise figure is available. Quoting farmers, the NEERI report puts the figure at 1323 animals. Major losses were reported from Peddakanjerla (192), Eddanoor (983) and Sultanpur (78). While Buffalo deaths were more in Peddakanjerla and Sultanpur, in Eddanoor, deaths of sheep and goats were more.

Contrary to the belief that industrial development strengthens agricultural economy, industrialization in these areas has resulted in unemployment. Pollution has displaced several traditional professions, through dislocation of agriculture operations. Local fishermen were also forced to abandon their profession since there are no fish resources in polluted tanks and streams. Even the washer community is caught in this survival crisis, as there is no fresh water available to wash clothes. Nearly 59 fishermen and 40 washermen families are out of work.

Any direct employment has not benefited the local people substantially because of lack of educational and training facilities commensurate with the capital-intensive technologies established here. Thus, most of the skilled jobs are manned by 'outsiders' leaving only menial jobs to the native people. Also, industrial growth instead of acting as a catalyst for the local economy has destroyed it with indiscriminate degradation of environment and resources.

Check Your Progress - 1

Cite a few bulk drugs produced in Patancheru.

Note : (a) Write the answer in the space given below.

(b) Compare your answer with the one given at the end of this unit.

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13.6. CITIZEN ACTION

Industrial pollution in Patancheru was noticed by the environmental action groups following newspaper reports of a gas leak at M/s Volrho Ltd. A local action group, Patancheru Anti-Pollution Committee (PAPC) was formed to campaign against this with a medical practitioner being the focal point for people-based voluntary action in Patancheru. Already aware of the problem of pollution, Dr.Kishan Rao along with farmers and industrial workers organized a dharna before the Volrho factory. This demonstration marked the first step of organized protests by pollution victims. This group has its organic links with the state-level Citizens Against Pollution.

From July 10, 1986, to July 16, 1986, relay hunger-strikes were organized in Patancheru, demanding the government to initiate steps to control pollution. Following this, Sri. Shafiq-Uz-Zaman, the then Medak District Collector, met the PAPC on July 15, assuring administrative action. Apart from the general issue of pollution, PAPC at the meeting expressed their concern over the setting up of a hazardous factory related to fluorocarbons. Also, they conveyed the apprehensions of residents of villages surrounding the newly established Bollarum industrial estate.

Continuing this campaign, a Patancheru Bandh was called on July 16. On the same day, a procession of farmers marched to the State Assembly in Hyderabad and submitted a memorandum demanding prevention of pollution of resources through the establishment of a effluent treatment plant by every industry, and supply of protected water to the affected villages. A delegation also met leaders of other political parties, including the local MLA, P.Ramachandra Reddy. The participants of the procession later submitted a copy of the memorandum to the Member-Secretary of the A.P. Pollution Control Board.

Protesting the contamination of Asani Kunta tank of Sultanpur and Posamudram of Kishtareddipet, due to the overflow of industrial effluents, farmers of Sultanpur, Gandigudem and Kishtareddipet organized a rally in Bollarum industrial area on August 18, 1986. On August 21, 1986, the PAPC organized a dharna before the office of the Revenue Divisional Officer, Sangareddy, calling for immediate steps to control pollution. In-charge collector of Medak District, Dayakar Rao, promised to take steps to control pollution in consultation with higher officials and concerned people. The farmers alleged that Bollarum industries had deliberately breached the Asani Kunta since the effluents volume released exceeded the capacity of the tank.

Things did not move much. In order to force the issue, the PAPC organized a bandh in Patancheru on August 26, 1986. Sensing the public mood, the next day the State Cabinet of Ministers discussed the issue wherein it was decided to initiate firm measures to tackle the problem. Taking note of the unusual disease pattern in these villages, the Cabinet decided in principle not to promote concentrated industrialization. The District Collector and the RDO, along with some officials, visited some of the villages to have a first-hand account of the problem. The Panchayat Raj Minister, Karanam Ramachandra Rao, also visited the areas. Continuous pressure yielded results as twenty two industries were served with closure notices under Section 133 Cr. P.C in July-August, 1986. Though the industries obtained stay orders by approaching the High Court by promising to install individual ETPs within six months, in March, 1987. The action groups felt it was an extended chance for industries to prevent pollution. But, definitely, it was a set-back to their efforts, and the administrative efforts to abate pollution.

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A closer analysis of this struggle reveals several 'Push' factors which played significant role in the mobilization of the people. Firstly, the people opted to protest against the industries only when their basic survival was being threatened. Secondly, the educational campaign organized by the action groups involving University teachers, students and journalists confirmed many of the villagers apprehensions were true, about the colored water passing through their fields and villages. Modern technology and scientific knowledge was inaccessible to these predominantly illiterate villagers. Thirdly, failure of the industrial economy in raising the standards of living in the local area. It is generally believed that, more often than not, industries provide a substantial support to the local economy by offering jobs and also by increasing the purchase power of the people.

At a seminar in Tirupati on September 11, 1986, K.Purushotam Reddy, referring to Patancheru industrial pollution, said, "people have to organize themselves into action groups, since all political parties. and their leadership support industries ignoring the travails of people".

13.6.1. Campaigns

With the six months time ending by September 6, 1987, the farmers met the District Collector to enquire about the action contemplated by him. Since none of the industries had established individual ETP's, nor the common ETP was constructed: there was no enforcement. The farmers

under the leadership of Citizens Against Pollution and the Patancheru Anti-Pollution Committee announced their second phase of public protest entitled "Race Against Pollution". On September 12, 1987, about 500 bullock carts blockaded the Hyderabad - Bombay Highway for six hours and thereby succeeded in drawing the attention of District administration once again to the plight of villagers and demanded stringent control of pollution. On September 26, 1987, the Citizens Against Pollution alongwith anti-pollution committees of Patancheru, Jeedimetla, Nacharam, and Uppal, several students and social service organizations organized another race against pollution from Osmania University to Raj Bhavan, in Hyderabad.

As a consequence, the District administration ordered the closure of five industries which later obtained stay orders. Due to continued inaction over the problem, action groups organized a indefinite road blockade in the month of October, 1990. About 200 villagers participated in this demonstration. After years of peaceful protests, there were signs of violence in the campaign although there was no concrete act as such.

In an unprecedented move, the action groups decided to contest the Lok Sabha elections held in mid-1991. They felt that this was necessary to represent people's grievances, not made possible by the established democratic channels and structures. This area has traditionally supported the candidates of the Congress party which has been the ruling party since Independence, except during a period of 7 years from 1983-89. However, representatives in the Assembly and the Parliament failed to fulfill their expected roles vis-a-vis Patancheru pollution problem. On the contrary, action groups felt that their importance in the governmental hierarchy was the main stumbling block in solving the problem. Citizens groups, in order to overcome this constraint, fielded Dr.A.Kishan Rao as the candidate in the parliamentary elections. Though he lost the election, the voting pattern suggests the widespread support enjoyed by the leadership of the Patancheru movement.

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13.6.2. Lobbying

With Dr.J.C.Mohanty as the Medak District Collector, a new approach was adopted by the administration to solve the problem. Thus, the year 1988 was marked by a series of meetings, both at the district level and the secretariat level. Most meetings successfully discussed short-term measures like transportation of effluents, but failed to evolve a consensus on the long term measures to be adopted. With different perceptions among the industrialists themselves, the construction of common ETP's proposed at Patancheru and Bollarum has time and again run into rough weather.

Other measures like compensation and relief measures were also discussed. But at the implementation level, it was not satisfactory. Compensation paid to the affected villages was patchy. And it was never complete since the problem of pollution was not tackled in the first instance, while degradation of environment continued. Supply of drinking water through tankers was discontinuous.

On the suggestion of the PAPC, a student organization, organized a seminar on "Industrial Development and Environment" on March 24, 1989, which was attended by officials, scientists, some people's representatives in the local bodies and anti-pollution activists. This forum served as a interface between the activists and the administration.

In the interim period between the campaigns and demonstrations, without undertaking direct mobilization, action groups tried to keep the issue alive through different methods. As part of their

continued efforts at mobilizing public opinion against pollution, a number of journalists were encouraged to visit the area to have a first-hand appraisal of the situation. These visits resulted in numerous articles and news-stories.

In 1990, with the publication of a Status Report on Environment in Andhra Pradesh, proper documentation of Patancheru problems was started. Following the request of a team the then Union Minister of State for Planning, Bhage Govardhan, visited some of the pollution affected villages on July 29, 1990. In between, the action groups were successful in stalling the proposed establishment of a methyl iso-cyanate (MIC) technology based industry at Patancheru. This MIC technology is widely believed to be the cause for the worst chemical disaster in the mid 1980's.

This area was also toured by the former Chief Justice of India, Shri.P.N.Bhagwati, and Mr.M.C.Mchta, a renowned Supreme Court Advocate, in August, 1990, upon the request of the action groups. Even earlier, on 5th June, 1990, Mr. Anil Agarwal of Centre for Science and Environment, New Delhi, was taken around and appraised of the situation. These three visits were organized as part of a strategy to influence the thinking process at the decision-making level. Shri.Bhage Govardhan, in fact, wrote a letter to Ms.Menaka Gandhi, the then Minister for Environment and Forests, urging her to take positive measures in controlling pollution at Patancheru. Shri.P.N. Bhagwati while addressing the journalists on the eve of his visit, warned that the present situation may lead to consequences as had happened in Thailand; consequences like destruction of polluting industries.

13.6.3. Legal Recourse

Judicial role in the Patancheru problem evokes mixed reaction. Every judgment shorn of all language, meant only two outcomes: calling for study reports, and passing interim orders. Though the judiciary took a sympathetic view of the cause of the farmers, subsequently its response has been inadequate. On October 9, 1987, few farmers under the guidance of the action groups, filed a writ petition in High Court against 20 industries. The course of the legal path was full of obstacles, ultimately leading to nothing.

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Interim orders concern the disposal of effluents temporarily into the municipal sewers, pending permanent solution. Meanwhile different judges felt the need for detailed information from the experts point of view, like the APPCB, Committee of Experts and the NEERI. Unfortunately, APPCB failed to generate necessary data, with the other expert teams relying on scratchy information they could collect on their own. All this affected judicial decisions. Also, there was an implementation gap with regard to judicial decisions. It was basically due to the fragmentation of responsibilities between the Department of Environment (A.P.), the APPCB and the Medak district administration.

Finally, a writ petition (No.1056/90) was filed in the Supreme Court claiming compensation for the villagers victimized by industrial pollution. In its interim orders, on 19th September, 1991, Supreme Court appointed NEERI, Nagpur, to study the problem. Though this report was submitted in 1991 itself, the case is still pending to be judged upon.

13.6.4. Mobilization through Education

Activities of action groups can be categorized into three main areas : environmental education, data collection, analysis and information dissemination; mobilizing and organizing the public directly or through courts and the Press to oppose continued pollution of villages; and activities directly aimed at resolving environmental problems. Presently, awareness is wide spread among the villagers.

As is common with any other voluntary group, the CAP and PAPC worked with a series of constraints. Firstly, there is lack of trained human resources to carry out a comprehensive analysis - technical and economic aspects of the problem. But they benefited from the knowledge provided by the professions of their leadership, as it helped them in understanding the situation better than others. Yet, it was still very difficult for them to find an expert organization, to carry out an independent pollution impact analysis which would have given their campaign a sharp edge. Lack of access to authentic data constrained the campaign. Ironically, even the government and the industrialists do not possess enough data on the problem. Though this non-possession is more due to lack of will, it also indicates the wrong priorities of the scientific research institutions and universities; there are several such in Hyderabad. Another constraint is the lack of statutory support and judicial sympathy for the action group efforts to fight against agents of environmental destruction.

The methodology of the campaign has been continuously and consistently based on non-violent initiatives. This campaign did not target industries individually, but concentrated on forcing the system to perform. This helped in channelising, and controlling, the public resentment over the non-performance of the government, and industrialists. Thus, the movement could be sustained despite structural constraints and non—availability of resources. Moreover, it denied any chance for the politician-industrial nexus in the decision making structures to suppress the movement.

The inner structure of campaign was unique. While not collecting membership fees, and not receiving funds, its activities solely depended on the commitment of the participating members towards the espousal of the cause, and the time they can spare. Any expenditure was borne out of their own pockets, or by others but not from any formal source. This unique arrangement enabled the members to participate in the activity based on their will, time and money; thus it brings forth only the most committed, which is reflected in its string of successes. The informal functional pattern is the main factor for the broad support it enjoys without an ideology stringing them together.

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13.7. GOVERNMENTAL RESPONSE

While the government was not apparently indifferent to the demands of the pollution-affected people its actions reveal lack of conviction in tackling this problem effectively and firmly. Its role was incremental and was directed according to the dynamics of the local political process. This also meant continuous shift in its approach without reference to any particular policy, implying policy paralysis. Under the existing pollution control laws, every industry which discharges effluents has to obtain a no-objection certificate. Under Section 5, Environment Protection Act, 1986, the government can close, prohibit or regulate any industry and stop supply of water, electricity or any other service to any industrial unit which fails to control or prevent air and water pollution. Despite these and other provisions, firm measures are yet to be taken to prevent pollution.

Considering the gravity of problem, following intense public pressure, the Revenue Divisional Officer, Sangareddy, issued a notification dated September 4, 1986, in proceedings 1004/86, which declares that Nakka Vagu waters are unfit for drinking and for any human needs due to industrial pollution. Again, on 19 April, 1989, Joint Director (Agriculture), Sangareddy, declared Nakka Vagu waters unfit for irrigation purposes. Even though in the case of Bollarum no declaration has been made, "the RDO, Sangareddy, has reported that the untreated effluents discharged by various industries of Bollarum industrial area in general ..... joined the Asanikunta, an irrigation source which in turn had over flown and the polluted water joined the feeding canal of the ayacut of Sultanpur village and damaged crops".

However, the Regional Soil Testing Laboratory, after analyzing a few water samples from the tank of the Kishtareddipet, came out with the report that the water is potable and can also be used for agriculture. But an independent analysis report of the sample collected on August 29, 1986, has revealed that water from Asani Kunta and Posamudram was unfit for human consumption and was not suitable for irrigational purposes. Subsequently, the government through RDO's letter No.1004/86 dated 4/9/1986 declared the water in several villages as unfit for any human needs.

Many administrators see citizen action as a threat to orderly government, an interference with their work as duly appointed officials. They feel any grievance has to be channelised through elected representatives or established procedures. But, when these channels are choked up the alternative can be action groups. Even a government department had to seek the help of action groups. The letter from the Sub-Divisional Officer, Telecommunications, Patancheru, to the PAPC about the abnormal conditions in the telephone exchange due to air pollution and the request for guidance proves this. As one study of citizen involvement in environmental decisions concludes, 'voluntary citizen action has been a positive and constructive force for more responsible government".

13.8. INDUSTRIES ATTITUDE

The Patancheru Industries Association was formed earlier. The political influence of large industries is enormous, a fact not unknown in the Indian political milieu. Local leadership including legislators of all political parties remained silent. The status-quoist direction of this industrial-political force didn't change even after one among their industries was affected by pollution. A ice making factory had to be closed several times due to contamination of the source of its water supply by the effluents of the neighboring industries. The Patancheru Industries Association, whose leadership, comprising mainly of large industries, failed to tackle this problem. The scenario of this lackadaisical attitude can be understood as under.

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There are various ways in which economic power is translated into political power. The most potent weapon is the threat that a plant might close, depriving people of jobs and taxes for the government. State governments are highly responsive to such pressures from industries on which the local economy is supposed to be dependent. Contribution to election funds is another important political tool to rope in political parties and politicians. Industry is active in promoting it's interests where there is administrative discretion. Finally, industry has the financial resources and the legal and technical expertise for protracted court-battles.

Check Your Progress - 2 & 3

2. Who are the individuals who lead the campaign against industrial pollution in Patancheru, and which are the action groups represented by them?

3. How many industries were issued closure notices by the government in the first instance, and under which section?

Note : (a) Write the answers in the space given below.

(b) Compare your answers with those given at the end of this unit.

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13.9. SUMMARY

Environmental problems clearly delineate the link between environment and development. But this recognition is yet to permeate the social thought processes. With the result, areas like Patancheru continue to be neglected for short term goals. Different roles played by democratic structures with regard to pollution problem proves the hollowness of Indian democratic system. And, it further demonstrates that science and technology have been abused for partisan ends. Ultimately, the question which will be asked by environmental victims is, whose development at whose cost? Governments response has been inadequate towards problems caused by industrial pollution. At the policy level, it consistently refused to recognize the human suffering caused by pollution of resources. All its mechanisms favored the protection of industry, and property, irrespective of costs. Politics of survival dominate the thought process of conventional articulating structures. Only genuine people's movement could alter this situation as demonstrate in Patancheru. In the absence of response from different democratic institutions, emergence of action groups has been welcomed by the villagers. These groups received unstinted support from the victims in pressurizing the implementation mechanisms to take positive action towards pollution control.

B R A O U

13.10. CHECK YOUT PROGRESS : MODEL ANSWERS

1. The bulk drugs produced in Patancheru are sulpha methoazole, ibuprofen, trimethoprim and paracetamol.

2. Dr. A.Kishan Rao, Convener, Patancheru Anti-Pollution Committee and Dr. K.Purushotham Reddy, President, Citizens Against Pollution.

3. 22 industries were issued closure notices under Section133 Criminal Procedure Code.

13.11. MODEL EXAMINATION QUESTIONS

I. Answer the following question in about 30 lines each.

1. Write briefly about various industries in Patancheru and its surroundings and explain the pollution caused due to them.

2. What is the impact of industrialisation?

3. Write briefly about citizen action.

4. What is the response of the Government for the demands of the pollution affected people.

II. Answer the following questions in about 10 lines each.

1. Name some of the industries located in and around Patancheru.

2. What is the damage caused to economy due to pollution?

3. Name the villages wherein crops and lands have been damaged by industrial effluents flowing in Nakka-vagu.

4. What was the attitude of industrialists in Patancheru area?

D. Narasimha Reddy

BRAOU

UNIT-14 : ENERGY

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BRAOU

14.1. OBJECTIVES

After going through this unit, you will be able to :

* explain relation between energy and socio-economic development,
* describe the majot environmental issues in power generation,
* discuss about various aspects of nuclear energy.

14.2. INTRODUCTION

One of the basic ingredients necessary for the survival of human society is energy. Every human activity and for that matter all natural activities requires energy. In fact, the technological progress that has increased human productivity and potential has been accomplished by an increased command over energy. In the 17th century Europe, with the rise of modern science and the consequent evolution of machines led to harnessing of energy in a significant manner. The industrial revolution translated the growing streams of inventions to practical applications which emphasized on consumption of depletable energy sources. Thus the exploitation of wood and cool as energy source enabled a massive substitution of physical labor. Slowly coal began to be employed on a large scale in Europe after elimination of forest cover in 18th century. Oil and gas began to be used in late 19th century and more so since early 20th century.

The growth and development of a modern economy is significantly dependent on the availability of energy. And the availability of energy is equally dependent on the continuous availability of natural resources. Thus, the life of modern societies is inextricably dependent on the sustainable management of resources. Because of this single reason, exploitation of natural resources is relentless, despite the indicators of extreme resource depletion, and environmental degradation. In pursuit of sources of energy for insuring their lifestyle and survival, human beings have been their resourceful best in trying out for various sources of energy from time immemorial.

Historically, energy generation has been a major source of pollution, starting with the burning of dry leaves and twigs. Burning of everything and anything became the norm. Over centuries, ancient civilizations have learned. For people in Asian and African countries with a highly developed societal structure and culture, burning was based on the resources available, and within the natural regeneration capacity of the environment. However, the advent of industrial revolution, and automation has brought in new sources of energy - coal and oil - for the industrial productivity. Coal and wood fueled the construction of Western societies and Western-dominated technologies. The process of economic development that was initiated after Industrial Revolution led to increased energy usage due to following factors :

1) There is increase in greater usage of energy with the development of industries.

2) Growth of industries led to increase in demand for greater trade and commerce and transportation facilities which increased the energy demand.

3) Given these changes even the livelihood patterns also became energy intensive.

4) Development of technology led to substitution of mechanized energy for physical labour even in the agriculture and its allied sectors and

5) Increase in population ensured that there is a natural increase in the demand for energy.

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14.3. PROBLEM

By the beginning of this century, deforestation and mining was extensive, and have been the sources of oppression, exploitation, colonialism and conflict across the world. The pollution hazards associated with coal-based industry and products are widely known. In 1970, about 320 million tonnes of coal burnt produced 100 million tonnes of fly ash, and 25 million tons of sulfur dioxide. The London Smog is well known as the consequence of coal being used a source of energy extensively. However, in the past 40 to 50 years, the sources of energy have become more varied and advanced with technological development. Yet, the consequences of using several sources of energy have been nothing but environmentally-destructive.

It is widely believed that development requires a major increase in per capita energy use. As a result, planning in developing countries emphasized expansion of energy supplies. Consequently, per capita commercial energy use grew at an average rate of 3.6 percent per year in the 1970s. But, this growth has been costly, especially for the oil-importing countries.

World energy consumption is dominated by the rich industrialized countries. Similarly, the rich social sections in the developing countries account for most commercial energy, using automobiles, air conditioners, refrigerators, and other modern conveniences, and have created a rapidly growing

demand for commercial energy, especially for crude oil products and electricity. The interests of these sections have shaped energy planning. Thus, energy planning tended to focus on such large-scale energy supply projects as oil refineries and central power plants. There has been a consistent criticism of this approach on the premise that it has not effectively dealt with energy needs of the poor. Relying largely on fuel wood, dung, and crop residues for energy, mostly for cooking and heating water, many of the rural poor face an energy crisis that is virtually unknown in the modern world. The United Nations' Food and Agriculture Organization (FAO) estimates that about 100 million human beings now suffer an acute scarcity of fuel wood and about 1 billion have a fuel wood deficit.

Check Your Progress - 1 & 2

1. What is London Smog?

2. How many people suffer fuel wood shortage world wide?

Note : (a) Write your answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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14.3.1. Energy and Socio-economic Development

Numerous sources of energy are either in use or under development. Like

* Hydro electric power
* Solar thermal power
* Solar photo-voltaic power
* Wind power
* Wave energy
* Waste incineration
* Landfill gas
* Biomass energy
* Geo thermal energy

Economic growth for long time has been accompanied by increases in energy consumption. For it was believed that the relationship between energy consumption and economic development holds good both cross sectionally and historically. But recent trends of energy consumption patterns in the developed countries show that it is too simplistic to assume the need for increase in energy usage with the level of economic development. For example, between 1973 and 1985, the total energy use per capita in Organization for Economic Co-operation and Development (OECD) countries fell by 6% while per capita income increased by 21%. Such an experience of the developed world proves that there is no direct relationship between availability of increasing commercial energy supplies and economic development. Yet much of the developing countries continue to depend on traditional energy sources and the above said decoupling of energy use and economic development has not yet been witnessed here. With increasing population, depletion of natural resources, energy scarcities are widespread. Lack of capital and technological capacities hinder the development of adequate commercial energy supplies, with consequent deleterious effects on economic development. About 2.5 billion people in the developing countries have little access to commercial energy supplies.

14.3.2. Major Environmental Issues in Power Generation

Fossil fuels supply 75 percent of world energy demand. However, the combustion of fossil fuels and tropical deforestation have been estimated to add more than six billion tonnes and two billion tonnes of carbon to the atmosphere annually. Yet, the flexibility of oil usage and its relative cheapness have contributed to its attractiveness as an energy source, and it satisfies around 40 percent of world energy requirement including commercial and noncommercial uses. Coal and natural gas together contribute a similar figure. Energy from biomass sources like fuel wood and agricultural waste, forests and industrial processing residues is the major component of renewable sector.

Thermal Power Plants (TPP) release gaseous pollutants and heat to atmosphere, thermal discharge into water bodies, generate tonnes of fly ash and bottom ash, and to the increase in noise levels. The most significant environment risks posed by emissions from TPPs relate to the climatic change due to build up of carbon dioxide and acidic deposition from long range transport of air pollutants.

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When we are discussing the problems relating to hydro electric projects we are solely referring to the large scale projects that are byproducts of big (multipurpose) dams. Major issues related to large scale hydropower projects include the opportunity costs of diverting large tracts of land to hydro electric facilities; the consumptive water losses associated with the creation of large artificial reservoirs in arid regions; decrease in availability of fresh water downstream of the dam resulting in lesser dilution and subsequent deterioration in water quality; the disruption of migratory patterns of certain fish species and destruction of fisheries; the spread of water-borne diseases such as schistomiasis and malaria, the socioeconomic problems of dislocation and rehabilitation of people the potential of sudden dam failure with catastrophic loss of life and property. The ecological and environmental costs of large dams have been well documented.

Apart from ecological considerations, other constraints to hydel-power projects are inter-state disputes over sharing of river waters, rehabilitation of people likely to be affected due to construction of dams and inadequate funds.

Nuclear power generation is necessarily associated with the dangers of radiation and safety. Radioactive releases in the nuclear fuel cycle could cause somatic and genetic health hazards of a severity which by comparison dwarfs most of the hazards from hydro and thermal power generation. Inspite of the fact that India (as tropical nation) being well endowed with good solar energy source

we are unable to make much headway in harnessing this vital renewable source of energy because our policy makers and the scientific community are not giving proper attention in developing a cost efficient technology. The importance given to the development of non conventional sources of energy is clearly reflected in the Plan allocations for this sector. Less than 1% of the resources allocated to the energy sector goes towards harnessing of these sources of energy.

14.4. ISSUES AND CHALLENGES

After independence, in Indian Planning provision was made for energy to fuel the process of rapid economic development. The resources allocated to energy sector reflects this provision. In the first Five Year Plan Rs. 260 crores was allocated for energy sector which was 13.3% of the total Plan outlay and by seventh Plan it rose to Rs.55,130 crores which was 30.6% of the Plan outlay. Hence it can be seen that apart from increase in absolute terms, allocation for energy sector also increased in terms of its percentage composition in the total Plan expenditure. Not only the growth rate of energy consumption exceeded the growth rate of the economy for a long period of time but also a trend of faster increase in this when compared with several other developing countries has also been witnessed.

India has a variety of energy sources which are broadly grouped into commercial energy sources and non-commercial energy sources. The commercial energy sources include coal, petroleum, hydro power and nuclear power. The non-commercial sources of energy include fire wood, agricultural waste, residue leaves and cattle dung.

Traditionally, India is known for having large proportion of its energy consumption under non-commercial sources in comparison with commercial energy sources. With economic development, rate of commercial energy consumption has been increasing in large amounts. In urban India, 66.8% of the total energy consumption in the domestic sector was met from commercial fuels, compared to 91.1% coming from non commercial sources in the rural areas. Cooking energy constitutes nearly half of the energy used in the country, of which almost 90 percent comes from firewood, dung and crop wastes. Commercial energy accounts for a little over 50 percent of the energy use with industry as the major consumer of electricity and coal (58% and 90% respectively), and the transport, industry and household sectors as the major consumers of oil (44, 20 and 19 percents respectively).

More than 80 percent of hydroelectric potential in India still remains untapped primarily due to adverse environmental consequences of large scale hydropower development such as deforestation, undesirable exchanges in riverine ecology and massive displacement of communities. Decentralized hydropower schemes are not yet used on a significant scale, although they possess the potential of providing economical, efficient and environmentally benign sources of energy.

Check Your Progress - 3,4,5,6 & 7

3. What does OECD stand for?

4. What percentage would fuel needs are fulfilled by Dossil fuels?

5. What percent of our countries energy sector allocation go in for non-conventional sources?

6. What percentage of domestic energy consumption in urban & rural India come from commercial sources?

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7. Roughly what percentage of our country's hydro electric sources are untapped?

Note : (a) Write your answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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14.5. PERSPECTIVES AND ALTERNATIVES

The energy sector has always been accorded high priority in India's economic policy and planning. In terms of primary energy input, coal (hard coal and lignite accounting for 58%) constitutes the mainstay of energy supply. Since 1975, the annual output rate has risen by over 80 percent, whereby assuming an increase in mining output of 4 percent per annum, the known available reserves in the country today will last out approximately another 130 years. The situation with regard to oil and gas is however much more dismal. Consequent to the tapping considerable deposits in India, from 1975, the share of oil and gas in energy supply rose markedly. However, at the current level of production, known extractable reserves of oil are likely to last another 20 years, whereas this would be just under 50 years for natural gas.

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Since 1980, energy conversion losses have risen disproportionately. Due to dearth of pipelines, for instance, over 30 percent of the natural gas produced is flared. In the case of electricity, transmission and distribution losses account for 21.5 percent of total power generation. These heavy losses are primarily attributed to inefficient growth of power generation, particularly in the case of fossil-fuel combustion. Barely 31 percent of the primary energy input in thermal power stations is available as electricity - an outcome of the continued deployment of obsolete technologies in power stations. Thermal power stations continue to be by far the most important component of power generation in India followed by hydro power plants. At present nuclear power plants play only a subordinate role. Traditionally, the annual capacity utilization of Indian power stations has been low.

There are two ways in which an industry can generate, distribute and utilize energy more efficiently: for example by means of savings, energy recovery and process changes. Secondly, the industry can change over to an energy source that is cheaper and cost-effective.

Growing need of increasing population for agricultural land and industrial/commercial demand has led to degradation of forests. This has put tremendous pressure on fuel wood availability, and villagers particularly women are forced to walk longer distances and spend more time in collecting fuel wood (the reason for Chipko Movement). The growing fuel scarcity in turn leads to further denudation of forests and other woodlands. The unsustainability of such a biomass cycle has a very adverse impact on the ecological balance of the country. Wasteful burning of fuel wood and dung in inefficient cooking stoves is responsible for variety of eye, throat and lung diseases. In

fact, indoor air pollution has been recognized as a major health hazard, especially among rural women and children: over 60,000 children reportedly die every year in India due to acute respiratory infections.

The domestic fuel use survey conducted by National Council of Applied Economic Research in 1985 showed that in rural India nearly 90 percent of the energy was contributed by the biomass fuels. Likewise, about 90 percent of energy was used for cooking. Commercial fuels played only a marginal role, with kerosene being the most significant of them, used mainly for lighting. Nearly 92 percent of the biofuels till today is collected from nature. In this regard, producing energy through the biogas route is the most rational way of utilizing the precious natural resources. Biogas, which is basically a mixture of methane and carbon dioxide produced through fermentation of organic waste under anaerobic conditions is an extremely convenient fuel in the rural context. A National Project on Biogas Development was established by the government in 1981 to promote this technology in India.

14.6. NUCLEAR ENERGY

Like any large-scale project, a nuclear power plant dominates its environment, profoundly affecting the local real estate values, and economy, as well as physical environment of the community. The siting of a nuclear power plant presents special problems simply because of its scale and its staggering costs. The complexity of a nuclear power plant, both in technological organisational terms contributes to awesome difficulties in managing them. The skills required to operate it, the organization of a managerial infrastucture, and the establishment of means of control pose staggering problems of administration beyond the expertise and managerial capacity of the governments.

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The costs of nuclear power are always higher than predicted construction and operating expenses making nuclear electricity less competitive with that from coal fired plants. Construction delays (often 14 years), troubling reports of negligent work, a whole series of mishaps, some minor and some potentially major, inadequate inspections, cover ups, growing concerns about radioactive waste storage, proliferation of bomb materials, terrorism, disposal of spent reactors, and finally, anxiety over the health hazards of exposure to radioactivity, are the contributing factors.

In India, nuclear energy is considered as cheaply available, compared with other sources, only because of public ownership. Nuclear facilities in India are closely linked to defense requirements, and thus investments are not exactly open. The financial expenditure of Atomic Energy Commission is secretive, not even open to Parliament, and their figures pertaining to per KWH costs do not include the radioactive disposal costs, plant decommissioning costs and many other incidentals.

Table 14.1. **Growth Rate of Nuclear Energy in percentage (approx)**

Country	1960	1965	1969	1977	1987	1969-77	1977-87
1. USA	297	926	3940	46975	92982	1100	200
2. Japan	-	13	510	7994	26888	1500	200-250
3. India	-	-	420	620	1154	100	180
4. France	97	416	1771	5868	49828	200	800-850

Source : The World Energy Book.

14.6.1. Mining

Mining of uranium needs an extremely cautious process. The experience of Saskatchewan people, in Canada, with uranium mining activity in their surroundings typifies the dangers of uranium mining. Due to mining in this area, numerous lakes have been contaminated with radioactive material, including the ground water. Further, this radioactivity entered the food chain of the local people, American-Indians, through fish and air. Radioactive tailings, byproducts of the uranium mining process, can be seen dumped every where. In India, most of the mining is done at Jaduguda, in Bihar. There is very scanty data as to the status of these mines. However, there have been reports which describe a situation at Jaduguda mines no different from Saskatchewan.

14.6.2. Fuel Processing

The Nuclear Fuel complex, at Hyderabad, is the most important link in the Indian Nuclear Fuel cycle. The nuclear fuel required for atomic reactors is manufactured and supplied to this complex. The present operating capacity of the plant is about 80 tonnes of fuel per year for pressurized Heavy Water Reactor (PHWR). Enriched uranium oxide fuel, required specifically for Tarapur Atomic Power Reactors, is also manufactured at NFC using enriched uranium hexafloride imported from France under an agreement. The production capacities are planned to be expanded from 80 tonnes to 225 tonnes to meet the recurring demand upto Narora Atomic Power Project. Separate facilities are under consideration for meeting the requirement of fuel for 10,000 MWe programme. The safety record of the NFC doesn't reflect any strict adherence to International Commission for Radiation Protection (ICRP) recommendations.

In the middle of the 80's, the NFC authorities used to dump zirconium as a huge pile in an open area, without any fence protection. Consequent to a accident in which four people have reportedly died, a boundary wall was constructed around the complex. However, the surrounding ground water is polluted by nitric acid. Though there is no independent account to relate this pollution to NFC, it has to be noted that daily consumption of nitric acid in the NFC is anywhere between 10 to 12 Metric tonnes. Magnesium (M-Du) wastage is also one of the major problems.

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Apparently, there are no integrated pollution treatment systems. The railway wagons used for transporting nuclear materials, finished and raw, are also used for other purposes. No provision exists for their exclusive usage nor for proper cleaning of the wagons after use. These wagons, if not cleaned properly, and if used for food transport, it could be hazardous. Even though the employees are subjected to thorough procedures, supplied with protective clothing, and film badges to measure radiation exposure, regular dosage of radiation is never ruled out.

14.6.3. Nuclear Reactor

During power production, the major concern regarding nuclear power is due to the generation of enormous quantities of radioactivity, and associated ionizing radiations. While most of the radioactivity produced during power production is well contained in the reactor system, the gases and liquid effluents from the power reactor do contain some radioactivity, although the amount differs depending on the efficacy of the filter and treatment systems. The main components of this activity are (i) Argon 41 (ii) Tritium and (iii) Micro quantities of fission products such as Cesium-37 and Strontium-90. According to AEC: "to estimate the radiation dose to the public both before and during the operation of any nuclear facility, and thereby to ensure that the above limits are adhered to, a comprehensive environmental surveillance programme is established at all major facilities.

Amongst other things, this has the objective of establishing data on base line radioactivity, identification of critical pathways, and radiation monitoring both during normal operation and during uncontrolled releases".

Reactor Core Meltdown: While in operation, an atomic reactor builds up enormous quantities of heat in its core, which is carried away by a criss-cross structure of pipes for steam generation. To contain the excess heat, and for contingency purposes, all atomic reactors carry reactor coolant safety systems. These systems are varied in different countries - even the elements used as coolants are quite different. In India, heavy water is used as the coolant. The Heavy Water, acting as a moderator, controls the neutrons to sustain the nuclear chain reaction in the uranium fuel. However, in case of excessive production of heat due to loss of control over the process, the precautions to be taken to avoid reactor meltdown can be cumbersome, and sometimes unreliable. In India, the most publicized safety feature is the containment structure (a dome over the nuclear reactor), as part of the design. These containment buildings are designed to capture radioactivity in the event of a core meltdown accident. The containment building of a light water reactor consists of a gas-leak proof shielding and an additional concrete wall. But such a structure may not be sufficient depending on the seriousness of the accident. Situations that may contribute to containment failure are: overpressure, leakage, hydrogen combustion, steam explosion and meltthrough.

Also, all reactor containment walls are perforated by over one hundred pipes. Radioactivity could escape through these pipes or leaky connections.

In Germany, the Karlsruhe Nuclear Research Centre estimates that the containment building would contain the burst for five days at the most after a core meltdown accident. This is because heat expansion would continue to increase the pressure in the building. Thus, all the safety containment can do is to delay the release of radioactivity but it cannot prevent it.

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In the case of double containment, because of continuous expansion, even if the concrete structure withstands, the soft earth underneath could give away. This could result in tremors, depending on intensity, causing damage to any nearby structures. Finally, there is the possibility of sudden strong increase in pressure in the containment building on account of steam and hydrogen explosion like the ones that occurred in the Chernobyl disaster. The containment buildings cannot withstand heavy explosions.

The radioactive byproducts of the fuel elements constantly increase the contamination degree of the reactor's interior. Thus nuclear power stations are becoming more and more dangerous each year. In power stations of the size 1200-1300 MW, the annual amount of radioactivity that accumulates is ten times the quantity of that released in the Chernobyl disaster, according to a study by the Rainbow Group in European Parliament. The Soviet accident report says, the Chernobyl reactor disaster made an area of over 3000 square kilometers permanently uninhabitable, and it necessitated the evacuation of 135,000 people. It affected large parts of the European continent, and, according to official estimates, it will result in 6000 additional cancer mortalities in Germany alone. But, in this accident, a maximum of only 4 percent of the highly radioactive fissile products was released in Chernobyl. The reactor had only been in operation for 3 years, and at the time of the accident, it was only being used to a capacity of 7 percent.

The worst nuclear accidents, at Three Mile Island in USA and Chernobyl in Ukraine, resulted due to a combination of factors. Primarily, due to human error and violation of a number of safety procedures. In India, to prevent such accidents, a Atomic Energy Regulatory Board has been established to ensure effective safety review in three aspects - safety in design, during construction,

and in operation. However, these responsibilities in themselves are very limited in scope, considering the need of safety in the entire nuclear fuel cycle. Also, the Board is not an independent body, and is part of the Atomic Energy Commission. The AERB is just another wing of the Atomic Energy Commission. Further, even the AERB's functioning is not open to public scrutiny.

14.6.4. Shutting Down a Reactor

After 30-40 years of service every atomic reactor has to be shut down. With each further operational year of a nuclear power station, it will also become more probable that a demolition of the plant will be impossible on account of the high degree of interior radiation. It is now accepted that entombment is the best method, considering different variables including costs of the three basic techniques: entombment, mothballing & dismantlement - for disposing of nuclear reactors. At present, a West German test reactor has been entombed, and is being monitored as a test case. Also, Chernobyl's Reactor No.4 is entombed in nearly half a million cubic yards of reinforced concrete. The reactor's core contains nearly 455 pounds of plutonium. It will take 24,000 years for the plutonium to lose half its radioactivity, and another 24,000 years to reduce it by half again.

According to Nuclear Power Corporation of India, Tarapur Atomic Power Plant will be the first to reach the decommissioning stage, by 2005 A.D., RAPS in 2010 and MAPS in 2020 A.D. The cost of decommissioning, at a generally accepted rate of 10 percent of plant cost of each reactor could be a whopping sum of Rs.100 crores, which is a conservative estimate. In the case of a reactor stricken by accident, the cost could be much higher. The Government of India, in 2030 A.D., has to raise a special security force with all latest weaponry, to guard three atomic reactors against any kind of attack depending on the arms technology, to be mounted by any foreign country or terrorist organization.

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14.6.5. Safety and Disaster Management

However, whenever there were incidents of radioactive pollution and accidental releases, there was no possibility of independent verification - atomic power plants are shrouded in secrecy. Apparently, lack of information has a deleterious effect on the public confidence. There have been numerous instances of radioactive pencils being lost. A radioactive pencil which was lost near Devarakonda, in Nalgonda district, Andhra Pradesh, in 1987, is yet to be traced. There is no other independent authority, equipped with necessary instrumentation, to verify and monitor the levels of radiation in and around nuclear power stations.

For safety considerations,

a. Plants must be able to pass a tough, realistic test to ensure that even a total cooling system failure will not result in a meltdown or a dangerous release of radioactivity.

b. Plants must be designed to be passively safe without the active intervention of operators.

c. The political and technical problems of radioactive fuel waste disposal must be solved.

Radiation is a silent killer, none of our senses can detect it, except at very high levels. Disaster Management is handicapped by the following :

1. Lack of proper information, and unavailable information with the AEC & other specialized agencies.

2. The danger potential of radiation is not immediately perceptible.

3. People have to rely on measurements and interpretations of experts who are the only ones able to define what is 'normal', and what is an 'acute state of emergency'.

4. All 'measures of public security' would be left to specially trained personnel, both in normal and emergency situations.

5. Within our democracy, and the fundamental rights guaranteed by it, compulsory state measures have to be accepted. For longer periods the AEC becomes a State within a state. A real democratization of the system of energy supply is incompatible with nuclear power.

6. In case of a disaster, society and all affected persons would have to cope with the physical and mental effects of the accident for an incomparably long period, some times as long as 5,00,000 years.

Check Your Progress - 8, 9 & 10

8. How long will our coal reserves last at the present rate of consumption?

9. In which part our country uranium is mined mostly?

10. Name any two well known nuclear accidents

Note : (a) Write your answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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14.6.6. Radioactive Waste Management

Nuclear power stations generate electricity for a few years and they leave behind high-level radioactive waste for several hundred thousand years. Liquid, solid and gaseous radioactive wastes are produced in the mining of ore, production of reactor fuel materials, reactor fuel and numerous related operations. During the reprocessing of the spent fuel to recover and recycle the fuel, significant quantity of high-level radioactive waste is generated. Several technological options are

being considered, all over the world, for safe handling and disposal of such wastes - like burying in abandoned salt contained form - after the radioactive waste is compacted into glassy bricks - there is the concern that the integrity of the containment cannot be assured for hundred of years for which it is intended.

Now, as a temporary measure, spent fuel rods are being stored in cooling ponds at the plants-site: soon there will be no more space for these ponds. Countries like United States, France and Japan can afford to bury their radioactive wastes in some remote island, or in some Third World country. While, Sweden stores its wastes inside the tunnel drilled under the sea bed - there is a possibility of seismic tremors disturbing this burial.

Wherever they are buried on the Earth, critics of nuclear power consider the radioactive wastes generated by the nuclear industry to be too great a burden for society to bear. Since the high level wastes will contain highly toxic materials with long half lives, the safe keeping of these materials must be assured for time periods longer than social orders have existed in the past. Another method of radioactive waste management is, using the plutonium, separated from spent fuel by chemical processing, in the production of atomic weapons. If France has achieved 40 percent nuclear power generation, it also encourages countries like Pakistan and Libya to produce the so-called 'Islamic' bomb, and explodes some nuclear device or the other on the Mururoa Atoll, in Asia, almost every day - the nuclear fallout is being endured by people of New Zealand, and inhabitants of many pacific islands. These nuclear experiments are being conducted despite official protests of the New Zealand Government. And the government of Japan, despite the experience of Hiroshima and Nagasaki, permits the movement of US Nuclear warships in its territorial waters, and discreetly helps the western nuclear weapons programme. There is a wide gap between precept and practice, all over the world, in matters related to nuclear power.

Even the most advanced technological capability, of United States and other Western nations, is unable to cope with the challenge of ultimate safe disposal of nuclear waste.

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14.6.7. Unaccounted Costs

The real cost of nuclear energy is regularly ignored. The following costs are neither estimated nor publicized; all of which are recurring ;

1. Ultimate safe disposal costs of the nuclear waste pile, which is growing every day.

2. Financial costs which our descendants have to raise to ensure that this waste is permanently monitored.

3. Demolition costs of the reactors contaminated by high-level radiation - widely agreed to run into billions of rupees.

4. Expenditure on large-scale policing operations of the reactor-in-action, waste disposal sites, and demolished reactor, ultimately, has to be added to the cost of nuclear power.

5. And, finally, nobody knows, how expensive will a major reactor accident be for the country - the economic cost of Chernobyl accident is estimated at 11 billion roubles (Medvedev, 1990)..

6. Costs incurred on the front-end side of the nuclear fuel cycle - research and development, processing and reprocessing, mining, etc,.

All nuclear reactors have to be disposed after a life-span of 30-40 years when they are-too old to run safely or economically - generally called as decommissioning. Three basic techniques are used for decommissioning.

a) Entombment, which means encasing the whole reactor in concrete and leaving it in place. For example, an area of 200 hectares has to be completely sealed off and monitored for years, because nuclear reactions continue to take place even after a complete shut down.

b) Mothballing, which requires some initial clean-up using high-pressure water hoses and then isolating it for decades until the reactor is 'passive' and then shipped away for burial.

c) And immediate dismantlement - rapid decontamination and disassembly.

In the next decade, some 50 plants in the Western nations will have to be decommissioned. There are now about a dozen US reactors awaiting disposal. The largest nuclear plant in the world to be decommissioned so far is the 72 MW unit at Shipping port, which was closed in 1982 - its 1000-ton reactor vessel had to be transported some 10,000 miles for a decent burial in an earthen trench.

Decommissioning in India is impossible considering the infrastructural conditions and resources. Almost all Indian nuclear facilities are in the midst of thickly populated areas; entombment means large scale evacuation.

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14.6.8. Comparative Costs

The general contention of the pro-nuclear lobby is that, unlike fossil fuel sources, nuclear power does not release carbon dioxide, the green house gas. But here the risk analysis is often selective and discriminatory. A proper risk analysis will follow these guidelines :

1. Analysis should be comprehensive, consistent and continuous.

2. A procedure called a method of properly allocated risk need to be followed. The risk should be annualized or normalized over the life-time of the energy system.

3. Environmental effects should be separated from health effects, as also with delayed and immediate effects.

4. Public and occupational risk should be distinguished from each other, public risk is attributable to various sources.

5. Data used in risk calculations are often quite variable even within one country. Transnational data cannot be mixed indiscriminately.

6. Long-term effects should be handled in the same way for each system compared.

Ultimately, all these costs are never reflected in the electricity rates. The question is: who will pay for these costs?

Most probably the future generations, and definitely not the consumers of such electricity.

14.7. OPTIONS, ALTERNATIVES AND CHOICES

In India, the peak power shortage, in 1993-94, of 16 percent was estimated to rise to 30 percent in 1996-96, notwithstanding the new capacities. Thus, now in the libe alization era, the spotlight is on the envisaged private sector participation in power generation. It is estimated that from 90-odd projects, about 40,000 MW can be generated with an investment of about Rs.1,40,000 Crore. This 40,000 MW is sought to be generated through the conversion of one form of energy (coal, lignite, oil or gas) to a more usable form like electricity. In fact, no conversion is possible without a significant loss of energy. Hence, it is necessary to consider the loss while calculating net availability from total commercial energy generated from primary sources like coal, crude, gas, hydro and nuclear power. This approach offers a better picture of growth rates, per capita consumption and scope for optimization through a change in energy-mix.

Interestingly, Renewable Sources of Energy (RSE), fuel wood and crop residues can contribute more energy with lesser investment, but they somehow do not attract sufficient interest. But, unfortunately, even the estimates of other sources of energy like fuel wood and crop residues vary widely. Hence, any analysis is bound to be incomplete, even after taking the non-commercial sources into consideration.

The Centre for Monitoring of Indian Economy (CMIE) has estimated the gross availability of energy for the year 1991-92 as 193.66 million tonnes of oil equivalent (mtoe) and the net availability (after conversions) as 130.62 mtoe. The compounded annual rate of growth (CARG) for the period 1981-91 threw up interesting figures. While the gross availability grew by 6.9 percent,net availability grew by only 5.3 percent because the CARG of conversion losses was higher at 10.5 percent.

BRAOU

This is because emphasis increasingly has been on thermal power. Today, about 65 percent of the country's energy requirements is met through coal based power. Hydel power accounts for a little more than 20 percent. Nuclear power's share is a mere two percent which is less than that of oil and gas which contribute twice as much.

Hydel energy which contributed nearly 50% of the total power consumed in 1970-71, is losing its share in spite of being cheaper to generate. The Central Electricity Authority has estimated the potential at 600 billion units(BU) per annum. The generation of hydel power in 1993-94 was just 70 BU.

All the four sources, coal, hydel, fossil fuels & nuclear, are environmentally destructive one way or the other. Firstly, except fossil fuels to an extent, the other three need massive investments and heavy infrastructural costs, with long gestation periods. They are centralized technologies. In comparison, considering all variables, dependent and independent, the optional scale should be based on this order: hydel, coal and nuclear; hydel power is the best choice among the three.

The environmental impacts of coal, hydel and fossil fuel sources of energy, though undeniably true, are confined to a specific space and a certain time. Depending on the intensity of the impact, after a few years nature retains its equilibrium. If not, the present state of technology can always decrease that intensity. Also, the three sources are environmentally benign at the micro-level, if appropriate technology is used. In the case of nuclear energy, it can only be tapped at the macro-level and hence, becomes, environmentally disastrous.

But it is also feasible to generate power with available technology on mini and micro projects. Unfortunately either because of the mind set or due to interests of big contractors being involved the policy makers always tend to de-emphasize the smaller projects in favor of larger ones. Of late, there have been efforts to involve the private sector in mini-hydel plants which do not face similar problems. Efforts are being made to harness wind power which is estimated to have a potential of 20,000 MW. Interest in the field is growing, thanks to tax benefits.

It is widely accepted that Renewable Sources of Energy (RSE), such as biogas, wind and solar power, are ecologically attractive. But, this choice is ruled out in certain quarters citing two reasons:

1. RSE cannot cater to the requirements of our energy-intensive economy, and as such cannot be a substitute for conventional sources of energy.

2. RSE is not cost effective.

But, these factors pale in comparison considering the following aspects. Since the era of modern technology, it is worth remembering that most of the technologies used for civilian purposes have germinated from the R & D of military requirements - from health & transport to energy. Thus, the Research and Development costs of conventional sources of energy was borne by societies, under the defense expenditure which is unquestionable in any country.

There are no recurring costs in RSE unlike conventional sources which incur huge capital costs, recurring costs, and accident costs. Additionally, the RSE cost efficiency is high, whenever it is centralised to a particular level, like a village. RSEs have an important role to play in India in the non-commercial sector.

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14.8. SUMMARY

Fulfilling fundamental human needs and improving the quality of life are the primary purposes of a development process. The development objective must be understood as the capacity to achieve social and economic growth in an environmentally sustainable manner, based on a long term perspective, so that the interests of future generations are not compromised by decisions made today.

Energy input, its concentration and quality, is the main determinant of human productivity which, in turn, determines the level of wastes, pollution and the rate of resource depletion associated with any particular industry and a given society generally.

14.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The London Smog is a well known example of consequence of coal being used extensively as a energy source.

2. 100 million people.

3. Organisation for Economic Corporation and development.

4. 75%

5. Less than 1%

6. 66.8% in urban areas & 9.9% in rural areas.

7. 75%

8. 130 years

9. Jaduguda in Bihar.

10. Three mile Island in USA & Chernobly in Ukraine. (Former USSR).

14.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Write a brief over view of the energy scenario in India.
2. What are the safety and disaster management measures in a nuclear reactor?
3. Write about cost benefit analysis of nuclear energy?
4. What do you think are the alternatives for nuclear energy?

II. Answer the following in about 10 lines each.

1. What are the major environmental problems in power generation?
2. Write about radio active waste disposal?
3. What do you understand by nuclear fuel processing?
4. What are the various sources of energy that are developed and are in developing stages?

BRAOU

D. Narasimha Reddy

UNIT-15 : HEALTH

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15.1. OBJECTIVES

After going through this unit, you will be able to :

* describe the environmental hazards,
* discuss about health problems due to urbanisation,
* list out the water-borne diseases,
* describe the effects of Arsenic pollution and fluorosis.

15.2. INTRODUCTION

Although there is no precise definition of development, it is widely understood to be a process resulting at least in improved health and longevity, higher productivity and living standards, enhanced local problem-solving capability, and increased access to essential goods and services. Quality of environment is the fundamental building block in the development process. The quality of environment influences economic development, employment, agriculture, housing, health, and numerous other sectors. Health, according to World Health Organization, is a "state of complete physical, mental and social well-being and not merely the absence of disease or deformity". Disease and poor health exact a heavy burden on the economy, the community, the family, and the individual.

Presently, with all the modern development, modernization, and sophistication, none of the countries were able to provide 'a state of complete well-being' in general. There are several factors, depending on the country, region and areas. Even the pattern of disease and deformity also varies. While half the world is still battling the diseases of yester years, there are new ones which are baffling the modern science with their effectivity and range. Also, previously, diseases which have thought

have been eliminated through vaccination and health care facilities and hygiene have come back with vigor, like malaria, and plague - in more virulent forms. It is now said that present disease vectors, viruses and bacteria have become resistant to the drugs which were the saviors of the populations earlier. Or is it the case of a reduction in the resistance of human beings to diseases?

With modern medicinal systems based on chemical drugs and digital machinery, even health care became a industry, a commercial enterprise, and beyond the reach of millions of poor people across the countries. Increasingly, diseases are now being classified on the basis of the income and lifestyles of the people. Thus, the poor people are still battling the older water-borne diseases, upper crusts of the society are concerned with cancer, consequences of obesity, work culture, AIDS, etc.. However, in urban areas these diseases are now percolating through the middle and lower social classes.

Earlier it was a organic environment, bacteria, viruses, and various other vectors, which caused health problems, either through the surroundings or through the food chain. Now it is the chemical environment, industrial and automobile pollution, chemical contamination, radiation, poisoning, etc., which is causing health problems in an unprecedented scale through the surroundings and the food chain. Coupled with this, the lifestyle of individuals and a whole community has brought in several other health problems.

Alarmingly, the present causal factors of ill-health, are affecting the humans to such an extent that there is a fear that there is also a under-the-mat genetic mutation.

Whatever the cause and effect, the most important change in recent times is that one cannot check upon or control the causal factors of his/her ill-health. Environmental pollution is caused by a few, affecting millions without their indulgence or consent. Even they may not enjoy the benefits of such an exploitative process. These can be termed as 'development' diseases.

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The whole causal web of these diseases has always excluded the victims from deciding their fate, politically, economically and socially. Industrial development had taken place in the villages without people's consent or knowledge, and also consequent pollution has ravaged their economy, resources, and lives without their consent. Also, a urban dweller has to live in a surroundings polluted by automobiles, inhale the dust which he mightn't be causing, etc. Further, everybody has to endure the consequences of deforestation in the form of floods, water shortage and drought. One such disease is fluorosis.

15.3. ENVIRONMENTAL HEALTH

Health due to environment can be characterized as environmental health, that is the environmental factors such as air, water, soil, plants, and trees, along with the growth of technology, population patterns vis-a-vis migration, occupation and urbanization. Thus, the knowledge of the nature and magnitude of the biological effects of environmental hazards and technological methods needed for their control are major components of the integrated social effort required to minimize the harmful consequences of a technological progress.

Environmental health has become a recognized field of considerable significance. The scope of environmental health has been defined by different groups and in differing contexts, but the principle definition is given as "human health effected by environmental factors". These factors are many. For example, wet lands infested by malarial vectors, emission of toxic gases from highly polluted

lake water bodies, use of chemicals in agricultural fields, pollution of air due to combustion of hydro carbons, pollution of drinking water by solid wastes, presence of dust particles in mining areas and use of ozone depleting fluorocarbons in the industry.

The problems of environmental health presents a very complex pattern and by no means is simple. It entirely depends upon the researchers basic thrust towards their defined goal.

15.3.1. Environmental Hazards

Environmental hazards can be broadly classified into :

(a) Air pollution, (b) Water pollution, (c) Soil pollution, (d) Radiation, (e) Pollution due to toxic emissions from industries and (f) Seepage of chemicals into soil and ground water.

By addition, environment is the aggregate of all the external conditions and influences that affect life and development of an organism. Therefore environmental agents consist of not only toxic compounds emitted by heavy industry, but also of chemicals used as pesticides.

The pollution which enters any biological system can be classified as : (a) Degradable (b) Non-degradable (c) Biologically accumulative.

Degradable pollutants include a large number of complex substances which undergo biological degradation through the activity of various types of decomposers, yielding simpler, inorganic end-products, such as carbon dioxide, nitrates, etc.. Microbial concentrations of such organisms as coliform pathogens, etc., also undergo reduction with time owing to natural die-off ; when they die, they become degradable organic matter. Fish and higher animals, similarly undergo biological degradation when dead. There is another group of degradable substances; the radioactive isotopes, which undergo physical degradation or decay, i.e. the time taken by the substance to loose its potency.

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Non-degradable substances are inert to biological action with time and are also called conservative substances, like chlorides and various salts. While certain organic substances may be termed as refractory substances.

Certain toxic metals such as mercury, cyanide, chromium, arsenic, cadmium, zinc, lead and cobalt accumulate in living tissues. Their capability for biological accumulation often makes them dangerous to those who consume them.

Those pollutants which can accumulate in the food chain are often referred to as persistent substances. The ability of a substance to be biologically accumulated is independent of its degradation characteristics, although over a period of time, the next accumulation in an organism will be less where decay is taking place, simultaneously with accumulation.

15.3.2. Effects of Pollutants on Human Health

There are no boundaries between soil, water and gaseous phases of the environment, pollution occurring in one phase can get transferred to another. Pollutants entering the environment may degrade or decay with time or remain inert. Hence, depending on the nature of the substance, a resultant concentration will be observed in the environment.

This condition will have various economic and health effects. The health effects may be due to the total body burden received, partly due to direct contact with air and water and partly through the ingestion of persistent substances such as pesticides that have accumulated in the food chain.

A substance can be classified as toxic, if and only the substances are present in the human body beyond a certain quantity. The biological response can be correlated with the actual amount of the toxic agent in the body.

The rate of absorption of an agent is related to the size, and weight of the species. In case of human beings food which is contaminated by the hazardous chemical elements usually finds its way into the human tissues.

The various pathways a hazardous chemical agent can enter the human body are as follows :

(a) Membrane penetration through skin, kidney, liver and brain tissues.

(b) Absorption by gastro-intestinal tract in the stomach.

(c) Absorption from the respiratory track.

(d) Blood contamination.

Thus, air pollutants, mostly in the form of vapors and gases enters into human body via the respiratory tract and lungs. Water pollutants enter the human body via liquids and foods ingested and pesticide residues through green vegetables, fruits and milk. DDT is a common pesticide residue in milk and fruits.

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Check Your Progress - 1 & 2

1. How do you classify environmental hazards?

2. How do you classify pollution which enters biological system ?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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15.4. HEALTH PROBLEMS DUE TO URBANIZATION

Due to the process of urbanization, people from rural areas tend to concentrate in a small area. Many urban centres have a density of population in excess of 10,000 persons/sq.km. (e.g. Central Calcutta - 70,000, Delhi - 50,000, Hyderabad - 30,000). Due to this high concentration of people, sanitation, water quality, solid and toxic waste disposal, segregation of waste based on their properties is an enormous burden.

Further, due to the close proximity of people and other biotic resources, the quality of ambient air may not be pure, instead the air may be contaminated by gases such as carbon dioxide, carbon monoxide which are exhaled by living organism.

Also due to the lack of green spaces in urban areas, the exhaled carbon dioxide and carbon monoxide by numerous sources cannot be converted into oxygen by the green vegetation and a shortage of oxygen results in the ambient air. This phenomenon can be observed in densely populated areas where smog, thick vapor in the form of colloidal particles such as sulfur dioxide, Hydrogen sulfide. Methane, nitrogen dioxide and dust can be present.

There are several examples of urban centres being effected by pollution. The common example of health problems due to smog are eye irritation, irritation of nasal tracts, respiratory tracts and skin irritation. In moderate quantities sulfur dioxide results in temporary spasm of smooth muscle of the bronchioles, in higher concentration, mucous production on walls of the upper airways and in still higher concentration severe inflammatory responses in the throat with the desguammmation of the surface epitheliums. These irritant effects of sulfur dioxide , especially bronchiolar spasm are aggravated by cold air. The reactions to these effects adversely modify lung functions.

A moderate degree of resistance may develop from continued exposure to this gas. Such resistance is found among industrial workers who are continually or repeatedly exposed to the gas in their occupations. This effect is believed to be due to the outpouring of increased amounts of mucous on to the walls of the throat.

15.5. HEALTH IN DEVELOPMENT CONTEXT

Health benefits result from improved quality and increased quantities of water, adequate sanitation facilities, and changes in hygiene behavior. These are available with development in the basic infrastructure like roads, water supply and sanitation facilities and education. Thus, development has to be comprehensive and sustainable.

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However, overexploitation of natural resources especially water, both surface and ground water sources, has brought in tremendous changes in the quality of life, and had deeply affected some of the areas. Thus, the changes in development has wrought in changes in the ecology and environment leading to problems of survival for millions of people in India. Two case studies are being presented here to highlight the after-effects and the negative fallout of development without an in-built component of sustainability.

15.5.1. Water-borne Diseases

Of the thirty seven major diseases in developing countries, twenty one are water and sanitation related. For ten of these twenty one, safe water and improved sanitation are considered as primary interventions for prevention: diarrhea, typhoid, schistosomiasis, amebiasis, hookworm, hepatitis A, ascariasis, giardiasis, trichuriasis, and racunculiasis. These ten diseases cause tremendous illness every year. According to 1993 World Bank's 'World Development Report', in 1990, mortality from the ten diseases was approximately 30,00,000, but the big killer among them was diarrheal disease with a total of 28,66,000 deaths.

To this list of diseases, there is an addition of the more modern health problems caused by ingestion of water contaminated with organic or inorganic compounds. Not much data exists on the magnitude

of such health problems in developing countries. But it is clear that increased industrialization, advances in agriculture, and growth in population and urbanization are increasing the severity of these diseases. Most developing countries face serious public health problems caused or aggravated by severely degraded environmental conditions. Agricultural practices have caused extensive water contamination with pesticides and salinisation of soils and ground water. Mining and industry have caused localized water contamination with industrial chemicals and metals. There are widespread chronic problems with unsafe drinking water and discharge of untreated sewage.

15.5.2. Arsenic Pollution

In West Bengal, in the districts of Nadia, Murshidabad, Malda, Burdwan, 24 North and South Paragans, the level of arsenic in drinking water varies from 0.06 to 3.7 mg per litre, while the maximum permissible limit (WHO) is 0.05 mg per litre. Because of this, about 1.25 lakh people have clear symptoms of arsenic toxicity. A prolonged intake of arsenic leads to hyper-keratosis and hyper-pigmentation. Arsenic can also induce peripheral neuritis resulting in motor and sensory paralysis of the limbs. Arsenic spares no age group. The worst affected district is Nadia. The inhabitants of eight of its 17 blocks drink water polluted by arsenic.

One million gallons of such water is supplied daily in the districts of Malda and Murshidabad alone. Water supplied through the Katlamari rural water supply scheme in Murshidabad has an arsenic concentration which is three times the maximum permissible limit. The Rajapur water supply scheme has an arsenic level of 0.104 mg per litre, while the Islampur water scheme supplies arsenic water almost four times the permissible limit. A tubewell in Kaliachak of Malda produces 147.8 kg of arsenic annually. In Debagram of Nadia, arsenic poisoning has grown on an epidemic scale. Half the population bear tell-tale signs of the calamity - ranging from lesions on the skin to bloated arms and legs. There is not a single family which has not lost at least one member to arsenic poisoning. Almost all the tubewells are contaminated, including the tube well at the Primary Health Centre at Purbasthali and the one at Beldanga Rural Hospital. School of Environmental Studies in Calcutta and the Central Ground Water Board did some studies on the problem.

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As geologists explain, the indiscriminate tapping of ground water through tube wells means too much is being drawn from underground. In Nadia district, 70 percent of water for irrigation comes from deep tube wells. The volume of water sucked up through tube wells far exceeds the natural replacement of the under ground water supply. The resulting imbalance sets off a geo-chemical reaction and causes arsenic to leak from the arsenic rocks underground. The over dependence on ground water is what causes this kind of tragedy.

15.5.3. Fluorosis

The origin of fluoride like most other minerals is associated with the volcanic and plutonic activities in the crust of the earth. It occurs as calcium fluoride and in plutonic rocks like granites in the form of fluorapatite. It also occurs in mica and calcium phosphate deposits. Basalts contain 100 ppm of fluoride and granites a high of 500 to 850 ppm. Shales and deep sea clay deposits have 740 and 1300 ppm respectively. Alkaline rocks contain the highest concentration 1200 to 8500 ppm. alkaline water also shows high enrichment of fluorine.

Fluorosis is a generic term used to describe the toxic effects of fluoride on the human beings. Excessive ingestion of fluoride leads to accumulation of the chemical dermatan sulphate in the bones and teeth. It tends to demineralize areas around it in the teeth and bones. Such demineralized

areas in the teeth get pitted, perforated and discolored. The belief that cavity occurs only in dental caries is outdated. In fact, there is an opinion that cavity formation may be aggravated in some cases by excess ingestion or use of fluoride.

Unfortunately, the use of fluoride for prevention of caries though formulated some 50 years ago by American dentists is still being promoted worldwide without questioning. Even the World Health Organization in its pamphlets advises people to use fluoridated water, tooth paste and salt.

However, the world over fluorosis is a major problem. China has nearly 32 million people with dental fluorosis and 1.75 million with skeletal fluorosis. A study in Senegal showed that there was mild dental fluorosis in 68.5 percent of the children at 1 ppm, when it exceeded 4 ppm the prevalence was 100 percent, in areas where fluorine in drinking water ranged from 1 to 7.4 ppm.

There are reports of high incidence of cancer in the U.S. resulting from fluoride. Animal experiments in Japan and other countries suggest that fluoride is cancer causing. Shockingly, the legal standards for fluoride in drinking water in the US has been raised from 2 ppm (parts per million) to 4 ppm and in toothpaste to 1,100 ppm (Newsweek, February 5, 1990). In contrast West Germany discontinued defluoridation after 15 years because of legal and health considerations. There is also no fluoridation in Japan, France, Denmark and many other countries. These developments are in contrast to the general belief that fluoridation helps the teeth.

It has been found that no tooth paste in India is free of fluoride. The fluoride content arising from the raw materials used - chalk, talc and calcium carbonate - may be as high as 800 ppm. Apart from this, the manufacturers add fluoride up to 2,000-2,500 ppm. Also, laboratory investigation showed that fluoride is not mixed uniformly in the paste. One of the brand of toothpaste reveal the quantity of toothpaste used either on the carton or on the tube. When sodium monofluorophosphate (SMFP) is added to the paste, it is known to decompose. But there is no expiry date is given on the tooth pastes.

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Indian dentists have shown that within minutes of using fluoridated toothpaste, the fluoride level in the serum is enhanced, the oral mucosa rich in blood vessels absorbs the fluoride ions rapidly. Fluoride does enter the blood directly from the oral cavity through the fine blood vessels in the mouth. The sublingual blood vessels (below the tongue) take the stuff directly to the superior venacava and then to the heart. Being a persistent bioaccumulator, the cumulative or additive effects of fluoride should be serious concern.

Fluoride replaces calcium in the bones through accumulation. This accumulation in the skeletal system manifests in the form of dental fluorosis (mottled or chipped teeth), skeletal fluorosis (pain or stiffness in joints) and non-skeletal fluorosis (gastro-intestinal problems, skin rashes and neurological disorders.

It has also been reported that fluoride may induce cholesterol formation in males causing cardiac problems. Excess ingestion of fluoride also causes kidney problems as confirmed by leading nephrologists. Muscular weakness, loss of muscle power and neurological manifestations leading to excessive thirst, and tendency to urinate frequently, although the volume of urine is not too large, are not uncommon among the afflicted individuals. Severe and widespread gastro-intestinal problems - anorexia, pain in the stomach, intermittent diarrhea, chronic constipation, gas formation and a feeling of bloated stomach (non-ulcer dyspepsia) - caused by drinking fluoridated water have also been confirmed. Using water with low levels of fluoride (less than 1 ppm) provides relief from these problems within 2-3 weeks.

There is data to suggest that 0.4 ppm of fluoride in drinking water causes varying degrees of dental fluorosis. Because of atrophy of muscle fibre and connective tissue, including oral cavity, caused by the use of fluoride, people living in endemic areas become endentuluous (loose teeth) at an early age and many resort to the use of denture.

The toxic effects of fluoride far outweigh the benefits at least in the Indian situation. As the soil is rich in fluoride bearing minerals, the water is fluoridated naturally. About 85 percent of the rural as well as urban population is solely dependent on ground water for drinking. The maximum fluoride content detected so far in drinking water is 38.5 ppm.

Fluorosis is considered a disease which has no treatment or cure, and the preventive aspects are often neglected. Therefore there is a search for water with less fluoride content.

15.6. FLUOUROSIS IN INDIA

Drinking water containing 1.5 to 38.5 ppm of fluoride has caused severe health problems in India for the last 50 years. Initially the problems were known to exist only in four states, two each in south and north. But today 13 states have been identified endemic to fluorosis and other health problems associated with drinking fluoride contaminated water. It has become an urban as well as a rural health problem, affecting the poor and the rich alike.

In India, states affected include Andhra Pradesh, Bihar, Gujarat, Haryana, Madhya Pradesh, Maharashtra and Orissa. Reports indicate that over 25 million people in nearly 8,700 villages in 13 states and Union Territories are exposed to high-fluoride water. The worst affected districts in Andhra Pradesh are Guntur, Prakasham, Nalgonda, Kurnool and Anantapur, where the number of problem villages are 204, 216, 163, 106 and 79 respectively. Reports indicate that the fluoride content in these districts ranges between 11 parts per million (ppm) to 2 ppm, while the permissible limit is 1.5 ppm. Fluoride content is increasing in other districts as well, like Mahbubnagar, Cuddapah, Krishna, Chittoor, Medak, Karimnagar, and Khammam. It has been found that fluoride percentage in Sompalle village of Mulakalacheruvu mandal in Chittoor district is 7.50 mg per litre of water.

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In India, district of Nalgonda in Andhra Pradesh is the most affected by fluorosis. However, it is spreading in other districts as well.

This is majorly caused by the usage of ground water through deep bore wells. With no method for replenishment of the withdrawn water, the depth of the bore wells kept increasing. Thus, people have been drawing water from the deep recesses of the earth, wherein it is contaminated by several salts. In the Deccan region, presence of fluorine increases with the depth. Thus, ultimately, it is the development pattern, which has ignored the existing surface water resources, decimated the watersheds, and has come to depend mostly on ground water, is the causal factor for the spread of fluorosis.

Its prevention lies in the usage of surface water for drinking and other purposes, replenishment of ground water reserves through watershed development, and restoration of surface water sources.

Defluoridation Efforts : . Even today some of the public health engineering textbooks describe procedures to fluoridate rather than defluoridate water. Even in the US early warning symptoms of fluoride toxicity/poisoning seems to have not been understood, as a statement illustrates

in the Chemical and Engineering News (August, 1988) that most doctors in the US have not studied the disease and do not know how to diagnose it.

However, since the early 1930s, the focus is on promoting epidemiological studies and basic and clinical research to understand fluoride's action on body tissues and the health problems in their totality. India is probably the first country to launch a national programme on fluorosis control or defluoridation.

In 1986, the government set up a Technology Mission on Rural Drinking Water (TMRDW) in the Department of Rural Development as the nodal agency to tackle the drinking water problem. Its mandate, to be accomplished in sub-missions, include :

1. Control of fluorosis
2. Eradication of guinea worm
3. Removal of excess iron
4. Removal of salinity and brackishness
5. Source finding and water management
6. Water quality surveillance

The methodologies adopted are :

1. Purification of water
2. Improvement of technical methods, materials, design and maintenance
3. Computerized management information system
4. Scientific source finding
5. Continuous monitoring and evaluation
6. Community involvement and awareness programmes

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Under the TMRDW, in the affected areas where there is no good source of water, domestic defluoridation procedures are being popularized, particularly among the lactating and expectant mothers, besides erecting community defluoridation tanks. Alternative sources of safe drinking water are also considered.

Excess fluoride can be removed from water by what is known as the "Nalgonda process". It involves rapid mixing of water with lime ($NaCO_3$ or $CaCO_3$), alum and bleaching powder (for disinfection). The process removes fluoride by flocculation. Lime ensures adequate alkalinity for hydrolysis of aluminum salts. If the water is sufficiently alkaline lime is not needed. This process is however has certain limitations and is not effective if in the waters total dissolved solids (TDS) is above 1500 ppm and the hardness above 250 ppm. The method is otherwise simple and can be suitable at domestic or community level. The only precaution needed is not to add excess alum, otherwise a residual metallic taste is felt. The Nalgonda process also involves removal of excess alkalinity and bicarbonates which is an added advantage.

The fill and draw type of community defluoridation system is used when water requirement is more. The cost works out to Rs.3 to Rs.5 per 1,000 litres. This uses the same Nalgonda process. Defluoridation units with hand pumps have also been designed and put to use in the rural areas.

A process to cleanse water of its excess fluoride through a process of stirring it in a mixture of alum and limestone was launched in certain districts in the state. Being a laborious process, it had to be abandoned.

Another process involves passing water through layers of activated alumina which has the property of sucking the fluoride and letting the liquid to pass through without any addition of any foreign substance. The activated alumina has to be washed periodically to clear away the fluoride that accumulates on the surface, after which it can be used again for the purification purpose.

A process based on herbs and medicinal plants is also being touted as a solution. However, this is yet to be established.

Many of these efforts have failed due to various reasons including technological non-viability. However, according to environmentalists, a sound water management policy through watershed development, restoration of small water resources and community management, will alone prevent the scourge of fluorosis.

15.7. CONCLUSION

Although it is important to know as much as possible about the etiology of water-related diseases, the work of providing water and sanitation to all should be focused on health, not on disease. Water supply and sanitation facilities have a long-run multiplier effect that reduces disease and mortality as a result of environmental improvement, rather than showing an immediate and direct impact on disease reduction.

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Water supply and sanitation are necessary but not always sufficient by themselves to achieve substantial disease reduction. Thus, the focus should be on the ecologically-sustainable methodologies, and a development pattern which accounts for the environmental resources.

15.8. SUMMARY

With all the modern development and sophistication, none of the countries were able to provide a state of complete well-being in general. With modern medicinal systems based on chemical drugs even health care became a industry and beyond the reach of millions of poor people. Earlier the diseases were caused due to bacteria, viruses and other vectors. Now, it is the chemical environment, industrial and automobile pollution, chemical contamination and radiation, poisons etc which is causing health problems.

Environmental hazards can be broadly classified into air pollution, water pollution, soil pollution, radiation, pollution due to toxic emissions from industries and seepage of chemicals into soil and ground water.

Due to urbanisation, people from rural areas tend to concentrate in a small area. Due to high concentration of people, sanitation, water quality, solid and toxic waste disposal are the main problems. Fluorosis, water-borne diseases and pollution due to heavy metals are causing lot of damage to human beings.

15.9. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Environmental hazards can be broadly classified into (a) air pollution (b) Water pollution (c) Soil pollution (d) radiation (e) pollution due to toxic emissions from industries and (f) seepage of chemicals into soil and ground water.

2. The pollution which enters any biological system can be classified as (a) degradable (b) non-degradable and (c) biologically accumulative.

15.10. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines.

1. Write briefly about environmental health hazards.
2. What are the health problems due to urbanisation?
3. Write about fluorosis in India and the efforts taken for defluoridation.

II. Answer the following questions in about 10 lines each.

1. What are the effects of pollutants on human health?
2. Briefly write about water-borne diseases.
3. Write briefly about arsenic pollution.
4. What is fluorosis? Briefly explain its effects.
5. How do you defluoridate water?

BRAOU

D. Narasimha Reddy

UNIT-16 : DISPLACEMENT

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16.1. OBJECTIVES

After going through this unit, you will be able to :

* explain about the rehabilitation of people due to major irrigation projects,
* discuss on the magnitude of displacement and the rehabilitation policy followed under different projects in A.P.

16.2. INTRODUCTION

In an effort towards 'development', a number of projects have been initiated all over the Third World. However, due to these projects, every year thousands of people were, and are being, displaced from their habitat and dispossessed of their land and source of employment.

According to one estimate since 1970, more than 35,000 large dams of more than fifteen meters each have been built all over the world, excluding China. Over the same period, the World Bank has provided finance to more than hundred countries and supported the construction of four hundred dams of varying sizes around the world. The breakdown of Bank assisted dam projects since 1980 is 14 percent in sub-Saharan Africa; 13 percent in Latin America and the Caribbean; 37 percent in South Asia; 17 percent in East Asia other than China and 19 percent in Europe and Middle East and North Africa (Scott Cuggenheim, 1989). Evidently, the Bank- assisted dam projects are more (54%) in Asia (South & East).

In India, with the adoption of planned economic development, many projects have been taken up. The contribution of these projects to the growth of output and employment are well published, but very little attention was paid, at least until recently, to their uprooting and dispossessing affects.

Table-16.1. A Conservative Estimate of The Total and Tribals Displaced by Developmental Schemes, 1951-1990

Sl.No.	Scheme	All People			Tribal		
		Displaced	Resettled	Backlog	Displaced	Resettled	Backlog
1.	Dams	164.00	41.00 (25.0)	123.00 (75.0)	63.21	15.81 (25.1)	47.40 (74.9)
2.	Mines	25.50	06.30 (24.7)	19.20 (75.3)	13.30	03.30 (24.8)	10.00 (75.2)
3.	Industry	12.50	03.75 (30.0)	08.75 (70.0)	03.13	00.80 (25.6)	02.33 (74.4)
4.	Wild life Sanctuary	06.00	01.25 (20.8)	04.75 (79.2)	04.50	01.00 (22.2)	03.50 (77.8)
5.	Others	05.00	01.50 (30.0)	03.50 (70.0)	01.25	00.25 (20.0)	01.00 (80.0)
6.	Total	213.00	53.80 (25.0)	159.20 (75.0)	85.39	21.16 (24.8)	64.23 (75.2)

Source : Walter Fernandes et. al.

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The high magnitude of development displacement speaks of the greater responsibility towards resettling the displaced families. But, what has happened is just the opposite. In fact, experiences clearly showed the careless approach of the government machinery on a critical issue like resettlement of the displaced. This can be noticed in the same Table-1. Seventy five percent of the displaced were left to their 'fate'. Worst hit by such development projects are the Tribals.

16.3. IRRIGATION PROJECTS IN ANDHRA PRADESH

Five major irrigation projects have been taken for discussion here. The five projects covered here are the Nizamsagar (1923-31), Tungabhadra (1945-53), Nagarjunasagar (1955-66), Sriramsagar (1963-?) and Srisailam (1960-?).

Nagarjunasagar dam (NSP), which is the largest masonry structure in the world, has been constructed across the river Krishna, near Nagarjuna Konda, involving large areas of submergence in two districts viz. Nalgonda and Guntur. The displaced have been rehabilitated through physical rehabilitation method, in more than 24 rehabilitation centres.

Pochampadu Project, renamed as Sriramsagar Project (SRSP) has been constructed on the river Godavari at Pochampad village in Nizambad district. A vast area has been submerged by the reservoir in the districts of Nizamabad and Adilabad. Unlike other projects, this project has three canals - Kakatiya Canal, Saraswathi Canal, and Laxmi Canal, to irrigate parts of six districts of Telangana. There are two balancing reservoirs, viz., Kadem in Adilabad district and Lower Manair in Karimnagar district, which are linked up by Saraswathi Canal and Kakatiya Canal respectively. Here, two methods of rehabilitation, namely Physical Rehabilitation Method (PRM) and Cash Grant Method (CGM) have been followed.

Srisailam Project (SSP) is basically a hydro-electrical project and providing irrigation to some parts of the state. This project is constructed across the river Krishna in Kurnool district at Srisailam. Some villages in two districts - Kurnool and Mahaboobnagar, have been affected by the project. The most tragic aspect of this project is the submergence of the ayacut area under K.C. canal of Thungabhadra Dam. Most of the submerged area in Kurnool district is localized area of this canal. In this project, CGM was followed to rehabilitate the displaced families.

The following table presents the number of villages and households affected by the above projects:

Table 2 - Number of Villages and families displaced

Name of the Project	No. of villages	No. of families
N.S.P.	57	5,098
S.R.S.P. and L.M.D.	117	41,471
S.S.P.	117	22,000
Total :	291	68,569

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Besides these projects, there is another project under consideration viz., 'Polavaram Project' which is going to submerge a vast tribal belt in Khammam and East Godavari districts.

The experience of people with regard to rehabilitation measures under five river valley projects is varied. These projects were executed over a period of seventy years beginning from 1920's. The experience thus includes the pre-independence as well as the post-independence period extending up to 1990.

16.4. NIZAMSAGAR PROJECT

Nizamsagar project, on the river Manjira, a tributary of Godavari, was constructed during the period 1923-31 by the Nizam government of the erstwhile princely state of Hyderabad. At the time of its conception and execution, it was the largest in the state and also one of the biggest storage dams in India. It was proposed to irrigate 2,75,000 acres serving 326 villages spread over four taluks of Nizamabad district.

16.4.1. Submergence

The creation of the reservoir affected 40 villages in two taluks, Yellareddy and Andole. A total of 5,037 houses in these villages were submerged. In one village, Achampet, only lands were affected. As many as 4,232 cultivating families were displaced and their land to the extent of 20,140 acres was submerged. In all 35,275 acres of land, including 15,135 acres of 'Crown Waste', was inundated.

16.4.2. Compensation

At the time of planning for the project, it was decided to pay compensation only for the houses likely to be submerged and not for the lands, since it was intended to provide 'land for land'. The Nizam's government was explicit in its proposal that for those whose lands were submerged, the same extent of land should be provided in the ayacut to be developed under the project. But there were apprehensions about the government's intentions. Some displaced persons felt that the government would not be in a position to provide proper facilities for resettlement. Others represented that payment of compensation for their land would give them the choice of buying lands at a place of their preference. As a result, the government's policy had to be changed to the effect that "if any ryot is unwilling to accept land under the 'channel' in lieu of his original holding, then compensation will have to be paid". But the government recorded its displeasure on cash compensation, as it was felt "that the people receiving compensation will fritter away the amounts and find themselves in the lurch with no house to live in and no land to cultivate and live on". The government nevertheless paid compensation to the lands of about one third of the total displaced persons. Before fixing the rate of compensation, the government had examined the land transactions and finally arrived at a figure ten times the assessment in the case of wet lands and fifteen times in the case of dry lands.

BRAOU

Regarding the houses, it was found that most of the houses were "more or less of one type". The value of the houses was fixed on the basis of model estimates of existing houses prepared by the PWD. About 14 per cent of the estimated value of each house was deducted "towards the cost of sale proceeds of timber, doors etc." and the balance was paid as compensation. Accordingly the wooden fixtures of the acquired houses were allowed to be removed by the house owners. Thus, for 4,232 houses the compensation paid was Rs. 10,58,000, which worked out to Rs 250 per house.

16.4.3. Rehabilitation Policy

Out of a total of 13,489 persons displaced, only two-thirds or 9000 persons were settled in the rehabilitation centres established by the government. The remaining one third or about 4,500 managed to rehabilitate themselves on their own in the adjoining villages after receiving cash compensation in lieu of land as well as houses. As mentioned earlier the government was not in favour of cash compensation in lieu of land. It was "felt that if the ryots are left to their discretion after paying cash compensation without making any arrangements for their welfare (i) it will reflect on the administration, (ii) it will cause great inconvenience and trouble to the ryots, and it will be against the interests of government to leave the ryots to themselves, instead of making them settle in the project ayacut, for which ryots are required for development."

The salient features of the rehabilitation programme of the then government were the following :

1. To offer the displaced ryots lands of their choice under the canal.
2. To offer lands for the construction of new villages.
3. To help them obtain necessary building materials.
4. To give a proper design for houses after making decent layouts with all facilities & amenities.
5. To make some cash payments for purchase of implements for agriculture, manure and other necessities.
6. To construct model houses economically.

There was explicit concern in the policy statement that "the above were to be got down as soon as the expropriation process is completed so that there may be no time left which would inconvenience the ryots and in turn delay the rehabilitation of ryots and development of the ayacut. These should be addressed to officers of outstanding ability and integrity, and the rest can be got over satisfactorily". Right from the beginning of the project, the concern for the displaced households and the earnestness in the implementation of the programme by mobilizing officers of proven integrity were the striking features of the rehabilitation policy.

However, one cannot but notice the contrast between the care and concern for the rehabilitation of the landed households on the one hand and the total absence of any programme for the rehabilitation of the landless households. The landless workers remain invisible even in the otherwise enlightened rehabilitation policy of the Nizam government. It may not be totally uncharitable to characterize the concern to rehabilitate the landed in the ayacut as not without an eye on the expansion of wet cultivation and the resultant higher land revenue. This becomes much more obvious if one takes into consideration the efforts of the Nizam government to induce cultivators from the far-off Krishna delta to settle down in the Nizamsagar ayacut.

BRAOU

Check Your Progress - 1 & 2

1. Who has constructed Nizamsagar Project and on what river?
2. How many villages were affected due to this construction?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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16.5. THUNGABHADRA PROJECT

Conceived as early as the mid-nineteenth century as an answer to the recurrent droughts of the vast rain shadow area of Rayalaseema, the proposal of the Thungabhadra project had a chequered career. At one stage, the project was proposed by the Madras Province to the Indian Irrigation Commission of 1901-03. The Commission in turn suggested that it could be taken up as a joint project by the Madras province and the princely state of Hyderabad. Since then, it took about forty years for both the governments to reach a settlement. Reasons for delay include, among other things, the prolonged negotiations for sharing water between the Madras Presidency and the Hyderabad state and the long delay in project design. Finally it emerged as a joint project in the year 1944. The construction of Thungabhadra project, at a cost of Rs. 100 crores, began in 1945 and was completed in 1953.

16.5.1. Submergence

In all 65 villages, covering three districts, Bellary, Raichur and Dharwar, were affected by this project. While Bellary district was under the Madras Presidency, Raichur and Dharwar were under the Nizam's domain. At present all the three districts are under Karnataka State. A total of 65 villages involving 8938 families consisting of 47,761 people were affected by the project. A study which covers the rehabilitation of the displaced in Bellary district alone shows that 38 villages in the district were submerged affecting 3713 households accounting for 17,761 people. The area submerged was of the order of 49,749 acres.

BRAOU

16.5.2. Compensation

Thungabhadra project is perhaps one of the earliest instances with which begins the vexed story of invoking the anachronistic Land Acquisition Act of 1894, (which was enacted for a totally different purpose) to settle compensation for the land submerged under the irrigation projects. The relevant notification under section 4(i) of the Land Acquisition Act, 1894 was published in the Fort St. George Gazette, Madras, dated 14-10-1941. The market value in 1941 was to be the basis of valuation of property. But actual proceedings for the acquisition of private lands commenced only in 1946. While the fixation of market value of 1941 itself evoked a lot of discontentment among the displaced families, the delay in payment of compensation by about five years added grist to their demand that compensation should be based on 1946 market prices.

Dissatisfied by the proposed compensation the families threatened by displacement launched an agitation and after four long years of negotiation the government was forced to consider the general price difference between the years 1941 and 1950, and sanctioned an ex gratia payment of 75 percent of the market value of lands in 1941-42, excluding 15 per cent solatium. Even this could not satisfy the people and the agitation continued further. Finally, the government conceded their demand and raised the exgratia payment from 75 per cent to 85 per cent excluding 15 per cent solatium. Besides, farmers were allowed to cultivate the non-submerged lands until 1953.

Regarding the compensation for buildings, the government adopted the method of valuation on the basis of original cost of construction but it was not acceptable to the farmers who suggested that the amount required for building a new house at current prices (1952) should be the basis for valuation. This suggestion was turned down by the government on the ground that the Manual of Land Acquisition did not permit such a basis for valuation. However, taking note of the

discontentment of the displaced, the government agreed to take 1950 market price as the basis since already ten years had elapsed after the gazette notification (1941). As a result an exgratia payment at 200 to 215 per cent of the cost of buildings was conceded.

16.5.3. Rehabilitation in Madras Presidency

Of the 65 villages submerged due to the Thungabhadra project, 27 villages were in the erstwhile Hyderabad State, while the rest were in the Madras Presidency.

The policy envisaged, for each affected cultivating family, an allotment of five acres of land in the command area, besides the compensation. Each agricultural family, including tenants, was provided with five acres of land for cultivation and ten cents of land for house site and cattle shed. Land for cultivation was allotted in the command area of the project. But some farmers did not accept the offer as the lands were far away from their original villages. Farmers preferred to take even dry land in the vicinity of their own villages than the wet land under the command area, which was inhabited by people with a different language and culture from their own. Merchants were provided shop establishments, besides house sites. Small hutments were built at a cost of Rs.325 each in the allotted sites for those whose compensation amount was less than Rs. 200 each. Some building materials like corrugated iron sheets through cooperative stores on no profit-no loss basis were made available to the displaced families. Other amenities provided at each rehabilitation centre were :

1. Well for drinking water - one well for every 50 households.
2. Roads : internal, approach and major roads.
3. Community hall: for every fairly large colony.
4. School buildings.
5. Dispensaries and Hospitals (central colonies).
6. Public latrine blocks (central colonies).
7. Weekly market sheds (H.B. colonies).
8. Parks, temples etc.

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Displaced families were also provided free transport to shift men and material to new colonies. Though some displaced families, as stated earlier, moved to upland areas, a majority of the households settled in the 40 new rehabilitation centres built in the ayacut area. The study by Gajarajan (1970) showed that the conditions of life in these rehabilitation centres were much better and could attract many families from non-displaced villages as well.

16.5.4. Rehabilitation Policy of Hyderabad Government (1953-54)

In the 27 villages, 5,225 families consisting of 30,000 people were affected. While the notification for the land acquisition was issued by the Government of Madras in 1941, the Hyderabad government did so in 1945.

Nineteen rehabilitation centres were established to resettle the displaced persons. The spirit of the Nizamsagar project was reflected in the rehabilitation of displaced persons under the Thungabhadra project as well. Lands were acquired for allotment to the displaced. An important aspect of the policy was the provision of land for cultivation and a house to live in to all displaced families including tenants and agricultural labour. The army was involved in the transportation of the material of the displaced families to new centres and in the construction of houses. The soldiers had put in their best effort to build one house a day on an average. And all the "model villages were constructed at hurricane speed. so that the displaced were re-settled in their new homes by June, 1953 when the villages evacuated were expected to be submerged." Besides allotment of land, cash loans, agricultural implements and housing materials were provided under credit. Multipurpose co-operative societies and a debt conciliation board were set up.

With the exception of a few who preferred cash compensation to settle on their own, most of the displaced families settled in the 19 rehabilitation centres in the ayacut area to their satisfaction. A reporter who toured the resettlement centres, wrote: "I tried my best to get reactions from the villagers themselves. No where could I find a word against government undertaking in the solution of this thorny problem".

16.6. NAGARJUNASAGAR PROJECT

Unlike the above two projects, Nagarjunasagar was planned and executed during the post-independence period. Nagarjunasagar was started in 1955 as a joint project between the then Andhra and Hyderabad States. It was completed in the mid 1960s.

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16.6.1. Submergence

The dam affected 57 villages in two districts viz. Nalgonda and Guntur. In all 25,000 people comprising 5,098 families were displaced. Most of them belonged to the Lambada and Chenchu tribes. No data is available on the acquisition of lands belonging to the displaced tribal population. This is not surprising, considering the fact that most of the tribal cultivators hardly had any title deeds to the lands that were possessed and cultivated by them for generations.

16.6.2. Compensation

Private lands were obtained as per the provisions of the Nagarjunasagar Project (Acquisition of lands) Act XXXII of 1956. Though this Act appears different in nomenclature from the Land Acquisition Act of 1894, it does not differ much in content. Land acquisition for Nagarjunasagar project was started in 1962 and it went on till 1966. But compensation was paid at the market rates prevailing as on 1.7.1953. The reason for fixing 1.7.1953 as the basis for market rate, as stated in the State Assembly in the course of a debate on this subject is rather ingenuous. It appears that people came to know of this project in July 1953, and therefore, this date was considered suitable for fixing the market rate. About Rs. 7.173 million for the lands submerged under the reservoir and Rs 3.06 million for houses and other structures acquired were paid as compensation. The Nagarjunasagar Project (Acquisition of Land) Act turned out to be worse than the 1894 Act as far as compensation to the affected people was concerned. As a result, the displaced households received compensation which was as low as Rs. 25 per acre of land. The state could get away with impunity because most of the affected people were tribals who were hardly aware of their deeds and rights.

16.6.3. Rehabilitation Policy

The rehabilitation policy proposed to provide a maximum of five acres of dry land free to each affected cultivating family holding not more than 20 acres and creation of rehabilitation centres. The following ground rules were laid down by the Nagarjunasagar Control Board to regulate the assignment of lands to the displaced families :

i) The grant of free lands to a displaced family should not exceed five acres of dry land.

ii) Only families that have been living by cultivation for the last three years should be eligible for the free grant.

iii) In respect of owners of land, only those owning 20 acres or less, taking their holding both in the submerged area and elsewhere into account, should be entitled to the free grant.

iv) In respect of owners of land, the rent should be just enough to make up for their total possession elsewhere and in new centres, subject to a maximum of 10 acres of dry land, including free grant of 5 acres.

v) An assignee will not be entitled to transfer the land given free in any manner for a period of five years from the date of allotment.

vi) In addition to any free grant of dry land which a family may be entitled to as above, each displaced family living by cultivation for the last three years and each owner of land whether owning less than 20 acres or more, may be assigned dry land on payment of market value, subject to the condition that the total holding in the new village did not exceed 20 acres.

vii) The following order of priority should be observed in the assignment of land on market value :

   a) Families with no land left after submergence, and

   b) In the case of families with lands left over after submergence, priority should be given to families with smaller holdings over families with larger holdings.

Apart from land assignment, other infrastructure and community facilities proposed to be provided at the new rehabilitation centres included :

i) Grant of house site.

ii) Provision of transport for shifting to the centres.

iii) Provision of water supply.

iv) Roads and common facilities.

v) Renewal of temples.

vi) Construction of chawadies-cum-community centres.

The displaced families were allowed to remove and take with them the dismantled materials of residential buildings free of cost whilst in respect of non-residential building materials it was permitted

BRAOU

only on payment of 75 per cent of the assessed cost. The cultivators threatened with displacement were also permitted to cultivate on lease, their land facing submergence, until such time as flooding occurs and the lease amount will be equivalent to the assessment payable prior to acquisition. In all 24 main and 10 subsidiary rehabilitation centres were established. Nearly 5,292 acres (2812 in Guntur and 2,480 in Nalgonda) of forest land was de-reserved for this purpose.

The actual implementation of the policy did cause a number of problems to the affected people. For example, the displaced in Elleswaram were allotted lands and house sites in another village where, much to their dismay the allotted lands were already encroached upon. An alternative site allotted was found not suitable for human settlement as it was rocky and no water was available. All these caused delay in their re-settlement. Meanwhile, the reservoir was filled with water due to sudden floods in the river and the village was submerged forcing the villages to take refuge on a nearby hillock. They lost all their belongings including some cattle in the floods. They were driven from pillar to post in the process of finding a place to settle down. Though the Nagarjunasagar was one of the worst rehabilitation experiences and the one that marked a turning point towards growing callousness, it did not draw much attention because of the relatively smaller magnitude of displacement, greater proportion of the affected being tribals and because of lack of public awareness of the problem in 1960s.

16.7. SRIRAMSAGAR PROJECT

Sriramsagar project is a major irrigation project meant to serve the Telangana region of the state. It is built across the river Godavari at Pochampad village in Nizamabad district. Work of the project started in July 1963. By utilizing 200 tmc of Godavari water, the Sriramsagar project is proposed to irrigate a total area of 16.109 lakh acres, 7.179 lakh acres in stage-I and 8.930 lakh acres in stage-II.

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16.7.1. Submergence

As many as 91 villages of two districts, Nizamabad and Adilabad, were affected due to the Sriramsagar dam. In addition, 26 villages were affected under the balancing Lower Manair dam. In all 117 villages with 47,599 families were affected. An area of 1,52,493 acres was submerged.

16.7.2. Compensation

No uniform method has been followed in the valuation for compensation. Each Special Deputy Collector (SDC), who was engaged in land acquisition followed his own method of valuation, as there was no clear stipulation about any particular method in the form of a government directive. However, in majority of the cases registration statistics were used as the basis for the valuation of lands.

16.7.3. Rehabilitation Policy

For Sriramsagar project the government had followed two methods of rehabilitation. They were (i) Physical Rehabilitation Method (PGM), and (ii) Cash Grant Method (CGM).

i) Physical Rehabilitation Method

There was no comprehensive rehabilitation policy except a government order that specified :

a) That displaced families shall be granted, free of cost, land equal to the extent acquired subject to a maximum of five acres of dry land or two acres of wet land per family. Families who were living by cultivation for atleast three years prior to displacement shall be eligible for such a grant. No further land will be assigned to the displaced families even on payment of market value.

b) i) That the displaced families who desire to get themselves rehabilitated at the centres established by the government will be granted 10 cents of land, free of cost, as house site, in the case of those whose lands have been acquired and five cents of land in the case of those whose lands have not been acquired.

ii) That displaced families who desire to get themselves rehabilitated in places other than rehabilitation centres established by the government will be allowed a cash grant of Rs.500 per family, in cases where lands but no house properties were acquired, a cash grant equivalent to 50 per cent of the compensation paid for such properties, subject to a minimum of Rs 500 and a maximum of Rs 2000 per family.

ii) Cash Grant Method

In 1978, the Physical Rehabilitation Method (PRM) was replaced by the Cash Grant Method (CGM) under the pretext that the contractors were reluctant to take up civil works at the rehabilitation centres. As a result of the change in the rehabilitation policy, only about 17 per cent of the displaced families have been provided physical rehabilitation, leaving others to their own fate. The number of families displaced and their coverage under PRM and CGM are given in Table 1. While 32 per cent of the displaced families in Adilabad district and 28 per cent of the displaced families in Nizamabad district have been provided physical rehabilitation, not a single family in Karimnagar district displaced by Lower Manair dam reservoir was provided physical rehabilitation.

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Table 16.2. Displacement and Rehabilitation in SRSP

Sl. No.	District	No. of Hs Affected	Families Covered Under PRM		Families Covered Under CGM	
			Number	Percent	Number	Percent
1.	Adilabad (56 villages)	13018	4197	32.00	18353	68.00
2.	Nizamabad (35 villages)	14275	3951	28.00	10324	72.00
3.	Sub total	27	8148	29.90	19145	70.10
4.	Karimnagar LMD (21 villages)	20306	—	—	20306	100.00
5.	Total families	47599	8148	17.00	39451	83.00

Source : Special Collector, SRSP.

Until 1978, before the change in the policy, the government had established 19 rehabilitation centres for 26 submerged villages of Nizamabad district and 12 rehabilitation centres for 26 submerged villages of Adilabad district. For the purpose of resettlement, the government secured about 36,428.33 acres from Forest Department and 2373.32 acres from government waste lands. Out of this about 1934.28 acres were demarcated to village sites and 23,428.33 acres for agricultural purposes. On an average a family was provided about 2.9 acres of land for cultivation.

Check Your Progress - 3 & 4

3. Where is Sriramsagar project?

4. How many villages and people are affected due to this?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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16.8. SRISAILAM PROJECT (SSP)

The construction of the Srisailam dam across the Krishna river near Siddeswaram village in Kurnool district was started in 1960 and took about 30 years for completion. Originally it was only a power project with a capacity of 770 MW. Later, irrigation was also added. Irrigation benefits are expected to be to the tune of 4.95 lakh acres. The costs originally estimated were overshot several fold.

16.8.1. Submergence

Submergence took place in three taluks each of Kurnool and Mahabubnagar districts. Of the total number of 117 villages affected, 65 are in Mahabubnagar and 52 are in Kurnool district. An area of 1,07,348 acres, including government land, was submerged under the reservoir.

16.8.2. Compensation

Out of 1,07,348 acres acquired for the reservoir, compensation was paid only for 84,755 acres. The remaining land includes partly government land and mostly lands cultivated by farmers since generations but without any title deeds except regular payment of land revenue. Until recently, about 46 percent of the displaced families of Srisailam project have not been paid compensation for their lands for various reasons.

16.8.3. Rehabilitation Policy

Though initially there were some efforts for physical rehabilitation of the displaced families, as the years rolled on the Cash Grant Method (CGM) emerged as the sole policy under Srisailam project.

The Government of Andhra Pradesh appointed a committee in 1965 to a suggest policy to rehabilitate the oustees of the Srisailam project. The committee recommended that the general pattern of land assignment followed in the Nagarjunasagar project could be adopted in the Srisailam project as well. But contrary to this recommendation, the government felt that it was "not necessary to adopt the Nagarjunasagar pattern in toto in the case of Srisailam and Pochampad projects" and gave directives modifying the principles followed to rehabilitate the displaced families under Nagarjunasagar. The result was the emergence of CGM as a major alternative with the following provisions :

i) Displaced families whose lands only were acquired might be granted 50 percent of the compensation paid for the lands acquired, subject to a maximum of Rs.1000.

ii) Displaced families whose houses only were affected might be granted 50 percent of the compensation paid for the acquisition of the house property subject to a maximum of Rs.1000.

iii) In the case of displaced families whose lands as well as houses were acquired, they might be paid 50 per cent of compensation paid for the acquisition of land and house properties, subject to a maximum of Rs 5000.

When the Government of Andhra Pradesh finally decided to abandon the PRM once for all in 1978, the CGM rates were revised, not on the basis of any debate in the legislature, but through a series of executive orders. And the CGM emerged as the sole rehabilitation measure, completely displacing PRM, ironically just at a time when rehabilitation of the displaced people had started attracting attention all over the world.

16.9. IMPACT OF THE POLICY

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Vacating the houses and leaving the villages, became a painful exercise. A situation had been created by the authorities that made people to leave the villages. The force of police and strength of the Bulldozers played an active part. In fact, quite a few painful incidents were reported in this regard. In one of the villages it was mentioned that the process of vacating people could not be stalled even when one of the women folk of the house was undergoing agonizing labor pains. The impersonal bulldozers and the inhuman Government machinery went on with their respective missions. In situations of this kind one rarely finds human element in the concerned authorities. It has become an 'Yagnam' to move men and material to the up land areas, as the fear of flood created by officials haunted the people. People were scattered into far off places. For example, the displaced people of one of the villages settled in more than thirty villages. Many villages reappeared a few kilometers away from the old villages on the uplands. This is due to the following reasons: one, they still have some lands left uninundated. Two, on the hope of cultivating the submerged lands when water recedes in the summer.

Most (81%) of the houses and their roofs in the old villages were built by stones. In the new settlements their number was reduced to 53 per cent. As all of them started constructing the houses at the same time the cost of material has gone up. House building has become costly. On an average, the compensation received for the old house forms just 23 per cent of the cost of the new hose. Generally, the roofs of the poor peoples' houses are covered by natural roofing material like palm leaves, special type of grass etc., the sources for which are at present in total submergence (Srisailam). There is a large scale deterioration in the assets and in the incomes of displaced families. In the case of lands, livestock and farm equipment, the deterioration was found to be

around 67, 50 and 30 per cent respectively. (Subramanyam et.al). Decline in the incomes ranged between 60 to 70 per cent on an average. Indebtedness has increased to (259%) a greater extent (Lokayan). It is appropriate to quote that "all those displaced but not rehabilitated have been forced to join the ranks of already existing unorganized sections". Further, "many others have become bonded laborers or daily wage earners under timber contractors and smugglers. We found over thirty thousand displaced persons from Orissa and Chattisgarh among the Asiad Workers in Delhi in 1982" (Fernandes and Ganguly).

This trend is not only specific to a metropolis like Delhi. Even in the newly emerging metropolitan cities like Hyderabad, the same trend is noticeable in the form of a persistent increase in the number of slums. For example, according to a recent study, the number of slums which stood at 106 in 1962, has increased to 811 in 1993-94, implying almost an eight fold increase. Agricultural laborers and marginal farmers were worst hit by this. Majority of them left the villages and went to far off places like Hyderabad, Bombay and Telugu Ganga project site in search of work. And their huts in the new settlements are in a dilapidated condition. Citing the examples of inconsistencies and inadequacies of rehabilitation in different states of India, K. Mankadi and T. Gangopadhyay say "In a developing country like independent India there is no access to colonies abroad for raw materials, cheap labor and markets. Hence the agrarian, forest and mountain dwelling communities provide the inner colonies' through whose exploitation and at whose expense rapid modernization can be carried out".

However, the rehabilitation policy followed by the previous regimes was more sensible than what is followed by the present 'democratic' regimes. One can look back into Nizams period and see the rehabilitation policy followed in the case of Nizamasagar Project and also observe the policy followed under Thungabhadra Project by colonial Government and by the Hyderabad State, before the formation of Andhra Pradesh. Physical rehabilitation methods were followed under both these projects. There is a rapid policy drift from the pre-independence period through the years of post-independence. The Nizamsagar experience shows extensive consultations with the people who were to be affected and they did exercise a role in deciding the policy. The Thungabhadra experience also shows that the displaced did play a role often by active mobilization as well as by consultation. But the 'Cash Grant' method doesn't have a place for the people who are affected in deciding about their own destiny. The new breed of leadership was more concerned with their middle men role in tampering with the records, in mobilizing the bribes and 'speed money'. As a result 50 percent of the displaced have been rendered ineligible for compensation. Those who are eligible have been paid a meagre amount.

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Low rates of compensation drove some of the displaced families to Civil Courts for enhancement of compensation. Due to lack knowledge about the Land Acquisition Act and its various provisions and due to lack of confidence in the effectiveness of the legal intervention, most of them did not approach the court in the beginning, But when the courts responded positively in the case of those who approached them, the others also filed their cases. But, the displaced families could not benefit by the enhanced compensation due to policy imperfection and this led to the involvement of middlemen to litigation. As a result, 29 to 58 per cent of enhanced compensation is misappropriated. The process of compensation has produced a strong class of middle men which is active in politics.

Many cultivating displaced families, under Srisailam and Sriramsagar projects, mainly those who fell under CGM, could not purchase even one fourth of the land that they had earlier with the compensation amount and as a result they became landless labor. This is because, the displaced families were left with no amount after meeting their immediate commitments. Government acted

purely as a Businessman in dealing with the displaced. The government adjusted the compensation against all the outstanding loans of displaced families. Private money lenders also got attachments to the compensation and snatched away a major part. Whatever little amount they were left with was wasted in unproductive activity. The present Land Acquisition Act only provides statutory right to Government to acquire land from private individuals for public purposes and does not provide any right to acquire the land to rehabilitate the displaced families. It is nothing but a violation of the 'right to live' which is enshrined in the Constitution. As said earlier, among the two methods (PRM and CGM), PRM has advantages over CGM from the point of view of displaced families in reducing their deprivation obtaining 'cash grant'.

16.10. SUMMARY

From a humanitarian and compassionate approach in the Nizamsagar resettlement, there has been a complete switch towards mechanical and bureaucratic approach. In the earlier approach, other amenities like drinking water, community hall, temple, school building, etc., were also listed. Transportation was also provided for shifting men and material to the new rehabilitation centres free of cost.

The experience of rehabilitation in Andhra Pradesh throws up the following aspects which could be taken up as issues requiring attention :

Firstly, one is struck by the continued degeneration and the volatility of the policy relating to the rehabilitation inspite of more than half a century of experience behind. The future of displaced families are left highly vulnerable and still left to the vagaries of the state policy.

Secondly, the policy formulation and implementation are apathetic and least informed by the growing public concern for the displaced families as much as by the questions raised by those challenging the received models of development, demanding alternatives. The result is a kind of retrogression in the policy from a more humane physical rehabilitation to mechanical cash compensation. There has been a shrinking of space for the human problem of displaced families in the concerns of the state policy.

Thirdly, a matter of serious concern is the growing legislative apathy to the rehabilitation of the displaced either as a part of the legislative process or otherwise. The results are seen vividly in the form of growing executive assertion and a tendency to interfere or even initiate rehabilitation policy through executive orders. As a consequence there has been growing room for fraud and corruption as well as emergence of a class of politician -lawyer - contractor - bureaucrat combine with a tendency to profit on the adversity of the displaced and the dispossessed. The consequences are seen in the process of genuine grievances transforming themselves into court cases which bring in a variety of dealers and wheelers specializing in the craft of claiming compensation.

Finally, the failure of the state and the resultant loss of faith in the policy pronouncements and the methods of implementation find expression in the form of activist and voluntary intervention which if combined with mobilisation of people's support alone could serve as a corrective not only to the state of rehabilitation policies, but also the nature of development programmes that serve as the sources of displacement.

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16.11. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Nizamsagar project was consturcted by the Nizam Government of the erstwhile princely state of Hyderabad in 1923-31 on the river Manjira, a tributary of Godavari.

2. Due to this construction 40 villages are affected in Yellareddy and Andole taluks.

3. Sriramsagar project is a major irrigation project built across the river Godavari at Pochampad village in Nizamabad district.

4. Totally 117 villages with 47, 599 families were affected due to this constructon.

16.12. MODEL EXAMINATION QUESTIONS

I. Answer the following questions about 30 lines each.

1. Comment on "Displacement in the process of development".

2. Write an account on Nizamsagar project.

3. Where is Thungabhadra project? Write on the submergence, compensation and rehabitation due to this project.

4. Write a brief account on Nagarjunasagar project.

5. Write an account on Srisailam Project.

II. Answer the following questions in about 10 lines each.

1. Write briefly an compensation given to Nizamsagar project.

2. What was the compensation given due to Thungabhadra Project?

3. Write about the rehabilitation policy of Hyderabad Government in 1953-54.

K. Muthyam Reddy

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BLOCK - 5
INSTITUTIONAL RESPONSE

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UNIT-17 : RESPONSE OF UNO AND OTHER INTERNATIONAL AGENCIES

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17.1. OBJECTIVES

After going through this unit, you will be ble to :

* describe the history of origins of international environmental movement,
* explain the role of the UN in International Environmental agreements,
* list out the International finance bodies and explain their role in global environmental concerns.

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17.2. INTRODUCTION

International concern over depleting resources and pollution began in the 19th century, mostly in Europe. The policy of the "white man" had been one of loot and plunder, and hunting was considered a sport, and good gamesmanship (for example, fox hunting was a great sport in England). With the expansion of the colonies in Asia and Africa, the white man found a whole new world to exploit. Wild animals were killed recklessly, forests were plundered, also mines, rivers, and lakes. Nature was considered as a treasure-house to be ravaged, and the right of the colonizer to this was considered to be supreme. The rights of the natives were however sharply curtailed, and they were alienated from their own lands. In America also, the white man, ransacked the environment, killing thousands of wild bison, and other animals. His superior weapons in hunting - guns, gunpowder, traps etc. made it easy for him to kill efficiently and on a large scale. Since his own forests had been wiped clean of wild animals, he found a rich hunting ground in the colonies.

But this large scale destruction of wild life led to serious thinking by many persons, in the late 19th century. The need for preservation of wild life was realized, and various groups highlighted the need for conservation of Nature. Slowly the movement got underway, and as increasing alarm at the loss of wild life spread through various countries of the world, the need for tackling the problem at the international level was felt.

In the next section, we shall have a look at the history of the growth of international concern over environmental destruction, and the measures taken up for conservation.

17.3. HISTORY OF ORIGINS OF INTERNATIONAL ENVIRONMENTAL MOVEMENT

Since the 1880s, England, France and USA, had started taking steps for the conservation of birds, and of places of historical interest and natural beauty. National parks were also set up in Canada, South Australia and New Zealand in the 1880s and 1890s. In the early 1900's, Sweden, Germany and Switzerland also established natural parks and societies for the protection of nature.

The destruction of wild animals in the colonies was also taken up in the 1880s. In South Africa, large game reserves and parks were established for conservation of wild animals. But these parks alienated the local population - the policy was "white men hunted, but Africans poached." The local people were marginalised, and punished if they were caught hunting on their own lands.

In 1909, an International Congress for the Preservation of Nature was held in Paris. After the I World War, an International Union of the Biological Sciences was established in 1928. This was consolidated into the International Office of the Protection of Nature, in 1934. Both in America and Europe, there was concern in some quarters, over the killing of wild animals in Africa. After the II World War, there were efforts to strengthen international nature protection. The idea of a new organization was mooted at a Conference in Basel in 1946, and taken up by the newly established UNESCO. In 1949, the new International Union for the Protection of Nature (IUPN), was launched. Despite constraints in funding, the IUPN struggled through for a few years. In 1956, its name was changed to the International Union for Conservation of Nature (IUCN). Its interest encompassed not only the industrialized countries, but also the countries of Asia, Africa and Middle East. Data collection on endangered species, and threatened mammals was initiated. The IUCN launched several projects in the early 1960s, with special attention to the developing world. The IUCN joined hands with the FAO, to launch the African Special Project in 1961. The IUCN also concentrated on the Middle East (Operation Onyx), Indonesia (orangutan and elephants), Nepal and India (rhino).

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However, the limited success of the IUCN was due to its "eurocentric" and First World approach, which limited its credibility in the Third World. Its meetings and conferences were dominated by the First World delegates, who could not realize the integral link between the livelihood of the locals with their natural surroundings. The former tended to look at conservation in isolation, while the Third World countries were concerned about the livelihood of their people who were dependent on the local environment. Thus, the domination of the First World members caused dissatisfaction to the members of the Third World countries. The latter emphasized the fact that conservation should be concomitant with development. These movements were the fore-runners of the concept of sustainable development.

The science of Ecology developed at the end of the 19th century, in Europe and USA. The research in ecology helped in understanding the intricate links between species, and their importance in maintaining the balance of nature. The growth of ecology gave more scientific reasons for preservation of nature and was the forerunner of the concept of sustainable development.

17.4. ECONOMIC FACTORS AND ENVIRONMENT

There was a further realization in the 1950s and 1960s, of the link between economic activities and their deleterious effect on the environment. But these developments were not accepted in the mainstream of economic theory or policy.

The effect of increasing population growth on environmental destruction was also examined in the 1940s and 1950s. In the 1960s, there was a wider realization that industrial growth was having a negative impact on the environment. The focus thus shifted from conservation of wild life alone, to the more encompassing one of conservation of the entire environment - i.e. both living and non-living systems.

The 1950s and the 1960s, were also the decades of economic growth and development. Technological revolution and progress made rapid strides in the First World, and there was a concerted effort to develop the newly independent countries of the "Third World". Industrialization was seen as the precursor for development, and increase in the GNP as the index of a country's economic prosperity. Hence growth of all goods and sectors that led to increase in the GNP were allowed, and new technology implemented with only the *economic* considerations in view, and not the *environmental* ones. But the new technology was highly resource and energy-intensive, and created massive amounts of pollution. This led to the depletion of natural resources on one hand, and increasing pollution on the other. In the bid for economic growth, the impact of growth on the environment was not considered in the main stream of economic policy.

The concept of "space-ship earth" coined by Kenneth Boulding, highlighted the fact that the world was one self-sustaining system, with no inputs except sunlight, from outside, and no place to dispose of wastes outside of the earth's environment. In the 1970s, the publication of "World Dynamics" by Forrester, and "The Limits to Growth", by Meadows, showed the global nature of environmental degradation - and the interlink between different growing systems. "Silent Spring" by Rachel Carson, brought out the harmful and irreversible effects of modern products, especially pesticides on the fragile ecological systems of the world. The emphasis thus shifted from the destruction of wild life, to the destruction of the world's environment, not through hunting, but through industrial growth. The realization of the trans-national nature of pollution, such as acid rain and nuclear fallout, spurred interest among the industrialized countries to find means of tackling environmental problems at the global level.

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Check Your Progress - 1

Explain the meaning of the term "Spaceship Earth". What is its significance to environmentalists?

Note : (a) Write your answer in the space provided below.

(b) Compare your answer with the one given at the end of this Unit.

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17.5. ROLE OF UNO IN INTERNATIONAL ENVIRONMENTAL AGREEMENTS

The global nature of environmental problems was debated at the IIIrd General Assembly of the International Biological Programme (IBP), at Bulgaria in 1968. By the 1970s, a number of UN bodies had included environmental problems in their agendas, though implementation was not very successful. Also there was a lack of coordination between different agencies and programmes. It was then felt that a body with an exclusive environmental focus was needed. This was then discussed at the Conference on the Human Environment at Stockholm, in 1972.

(1) **Stockholm Conference :** The U.N. Conference on the Human Environment held in Stockholm is 1972, was the first to recognize the need for national and international policies on environmental protection. Also, this was the first time that Governments participated in an international conference on the environment - with about 113 nations being represented, including India. The environmental problems discussed were chiefly those identified and experienced by the developed countries, such as the problem of acidification of Scandinavian aquatic systems. The focus was on pollution, population explosion, conservation of resources and limits to growth.

The conference established four major elements of the UN environment programme :-
(a) An Action Plan for environmental policy, (b) an Environmental Fund to be established by voluntary contributions from states, (c) new UN machinery in the form of the UN Environmental Programme, and (d) a Declaration of twenty-six principles on the human environment. Principles 8-14 relate to the interests of developing countries.

The Action Plan consisted of 106 recommendations. The Global Assessment Programme known as Earth Watch was set up, which was to consist of a Global Environmental Monitoring Service (GEMS), and an International Referral Service, later called INFOTERRA. Other goals included natural resource management, and training, and education and provision of information about the environment.

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The United Nations Environment Programme (UNEP), was set up to act as a Governing Council for environment programmes of the UN, and to finance them within the UN system. However, there was a lot of opposition to its establishment from the other UN bodies. Also many industrialized countries were reluctant to contribute necessary funds to this Programme. The UNEP was to serve as a catalyst in developing and coordinating an environmental focus in the programmes of other organizations, rather than initiating or mandating environmental programmes on its own account. However, it had no treaty of its own, nor supranational powers, or even an independent status of the other specialized agencies of the UN. Being short on funds, without proper direction or power, and situated at Nairobi, far away from the decision centre of the UN, it has not been as successful as expected, in ensuring proper compliance of international agreements on the environment.

However, UNEP has taken various initiatives in arranging joint programmes and inter-agency meetings - on marine pollution, protection of the ozone layer, transport of hazardous wastes, and climate change.

The North was interested in strict environmental controls, while the South felt that it was not to be penalized for the destructive activities of the North, to which it was not a party. On the contrary, the countries of the South, emphasized the need for enquiring into the interaction

between development and the environment and for focussing attention on such aspects as shelter, food and clean drinking water. Finally, these were accepted, and incorporated into the Stockholm Declaration.

The environmental issues addressed in this Conference were neither very specific nor binding. There were exhortations about pollution, the need for safeguarding wildlife and natural resources, to 'share' non-renewable resources and to co-operate in international issues. It was also felt that individual nations had the right to determine their population and resources policy. Also financial assistance to the Third World to improve the environment was mentioned.

However, only eight recommendations of the Conference addressed the link between development and environmental problems of the Third World, and these were "extraordinarily negative". It was felt that development need not be impaired by environmental protection, which could be solved through 'rational' planning and 'integrated planning' — but these methods were not explicitly spelt out. Hence, although the Third World countries could use their influence in including development issues, they could gain no other advantage here.

A positive consequence of this Conference was that many countries established their own Departments of Environment, and passed legislation on environmental protection.

2) **World Conservation Strategy (WCS) :** This report was prepared by IUCN with the financial help of UNEP and World Wildlife Fund, and published in 1980. It basically addressed conservation, and recognized for the first time that development could be a means of achieving conservation instead of obstructing it. The WCS provided a framework within which each nation could prepare a conservation strategy of its own. It highlighted the measures to be taken for conservation and preservation of ecological systems, but did not address pollution or non-renewable resource depletion.

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The concept of 'sustainable development' (SD), which was later popularized by the Brundtland report, had it origins here. "Conservation is the management of human use of the biosphere so that it may yield the greatest sustainable benefits to present generations, while maintaining its potential to meet the needs and aspirations of future generations." SD is development that can continue indefinitely into the future, for which life-support systems are needed. Hence it was felt that it is essential to conserve the biosphere.

The WCS recognized the fact that SD should be 'people centered', i.e. the benefits of conservation should be felt by local people, and should hence involve the local population. However it did not specify the role of the Government in conservation, nor did it examine the details of development theory and its modifications to incorporate SD. Neither were the special economic and environmental problems of the Third World countries analyzed in this report.

(3) **Brundtland Report :** A decade after the Stockholm conference, environmental crises continued to occur. This was because environmental protection was not being given much priority in the economic and political agendas of the countries that had participated in the International Conferences.

Hence in 1983, the World Commission on Environment and Development (WCED), was set up by the UN, and presented its report *Our Common Future*, also known as the Brundtland Report, in 1987. This Report reviewed the environmental issues of the world in the context of political and economic setting of international development. It recognized the fact that environmental problems

cannot be analyzed without a "broader perspective that encompasses the factors underlying world poverty and international inequality." Further, it was global in scope and recognized the need for multilateral solutions to environmental problems.

Sustainable Development (SD) was formally defined for the first time in this report. "Sustainable Development is development that meets the needs of the present without compromising the ability of the future generations to meet their own needs." It thus addresses: (i) the concept of 'needs' in particular the essential needs of the world's poor, to which overriding priority should be given, (also called the Poverty focus), and (ii) the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs, (the Future focus).

SD and environmental protection were firmly placed in the context of political and economic policies of international development. The reciprocal links between economic development and the environment, and between poverty, environment, and development, were recognised. It was felt that economic growth can tackle poverty - but this growth has to be of a *different type* - "sustainable, environmentally aware, egalitarian, integrating economic and social development, and more equitable in its impact."

Not only did the report emphasize the global nature of environmental problems, but it also sought to find methods by which the economic problems of the Third World could be tackled without further environmental damage. Since debt, poverty and population growth restrict the capacity of developing countries to adopt environmentally sound policies, the following solutions were proposed: First, capital flow to the Third World should be increased, but these should be directed to promote 'sustainable' projects, second, new deals on commodity trade, with especial attention to the hidden pollution costs of industrial processes in developing countries, and third, ending protectionism and reforming trans-national investment to ensure 'responsibility', such as through technology transfer and environmentally sound technologies.

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In spite of its very detailed and wide coverage of development and environmental issues, the recommendations of this report, were not binding. Although the concept of sustainable development caught on, and all manner of development and policy matters were assigned to it, still no policy action was taken for its implementation. Neither were the other policy recommendations of the Report put into practice by either the North or the South countries.

17.6. OTHER INTERNATIONAL AGREEMENTS ON ENVIRONMENTAL PROTECTION

1) **Protection of Ozone layer :** In the North, the depletion of the ozone layer was the cause of concern since the late 1970s. Although many countries took steps to reduce their output of ozone depleting substances, a global approach to it was considered necessary. The Vienna Convention for the Protection of the ozone layer, met in 1985, but no specific obligations to reduce ozone depleting substances were imposed. The Montreal Protocol held in 1987, decided that developed countries should reduce CFC production by 50% of the 1986 level by 1999, and production and consumption of halons (bromine compounds) would be frozen within three years. Developing countries were exempted for the first decade, within which time they were to receive technical assistance to make the transition to ozone-friendly technologies. However with increasing information about the rapidity of the ozone layer depletion, a series of meetings were held, and in 1992 at Copenhagen, all parties agreed to accelerate the phase out schedule to January 1, 1996.

2) **Control of Hazardous Wastes :** Many developed countries were shipping their hazardous wastes, including nuclear wastes, to developing countries. For example, in 1987, the Governments of Peru, Argentina, Paraguay and Uruguay, allowed the import of toxic wastes from America Security International at the rate of 100,000 barrels a month, receiving $40 a barrel for this facility. Benin, one of the poorest countries of the world, allowed a European firm to dump 5 million tons of wastes at $1000 a ton, and Lindaco of USA ships 6 million tons of chemical wastes to Guinea Bissan.

This created extreme resentment and fear in the Third World countries, on the environmental effects of dumping such hazardous wastes. In 1989, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, was convened. However, the decisions arrived here, were considered to be inadequate, if not actually legalizing such dumping. The convention did not address waste creation, but permitted such trade, provided the importing country was given information on the wastes, allowed agreements between signatory and non-signatory states, and did not give any precise definition for terms such as "environmentally sound" and "hazardous wastes". Also the Convention had inadequate enforcement and liability provisions.

3) **Earth Summit :** The UN Conference on Environment and Development (UNCED), organized this summit in Rio de Janeiro, in June 1992. About 170 nations participated, to "deal primarily with the environmental consequences of industrial society." The negotiations in this Conference brought out the fact that although there was common concern about the need for environmental protection, there was no common consensus about how it should be achieved, and who should bear the brunt of implementation. The Third World countries reiterated their stand that the problem of cleaning up the environment, was the task of the industrialized countries, who were guilty of dirtying it in the first place. Hence the responsibility lay with the First World, which should change its pattern and levels of consumption, and not force the Third World countries to implement unworkable environmental controls. The industrialized countries however, refused to commit to specific steps to reduce their own industrial growth and pollution, but continued to press the developing countries to protect forests and wildlife.

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In spite of these disagreements, Conventions on Climatic change and on Bio-diversity, and a Statement on forests were signed. The Rio Declaration and an action plan for SD known as Agenda 21, were also produced in this Conference.

(a) **Convention on Climate :** Climatic changes associated with the depletion of the ozone layer, and of increase in green-house gases, and the need to control and reduce such emissions, were discussed in this Convention. Climatic changes would basically affect the global commons. Developed countries, since they were contributing the maximum to greenhouse gases, were to take the lead to reduce them. Also they had to fund, through the Global Environmental Facility (GEF), the "full agreed incremental costs" of measures taken by the developing countries to shift over to alternative technology. Greenhouse gases such as carbon dioxide, were to be stabilized to 1990 levels by the year 2000 AD, by industrialized countries.

Though this Convention was signed by 143 heads of States, it was weaker than expected as there was resistance from the North and the oil exporting countries, to it. The European Commission agreed to adopt measures to reduce greenhouse gases to 1990 levels, if the USA did so. But the USA refused to comply, and so the whole treaty had to be watered down. It now does not require countries to set specific targets or policy measures to reduce greenhouse gases emission.

(b) **Convention on Bio-diversity :** This is sought to conserve biological diversity through the protection of species and ecosystems, and to establish terms for the associated uses of biological resources and technology. The Third World countries have the largest reserves of bio-diversity, but the First World has evolved more biotechnology. Hence there was no consensus on the recommendations of this Convention. While the former wanted to share the benefits of biotechnology, the latter wanted access to bio-diversity. Finally the Convention affirmed that States have sovereign rights over their own biological resources, though they do have the responsibility to conserve their biological diversity, and use the biological resources in a sustainable manner.

The Convention also recognized that access to and transfer of technology among contracting parties, are essential elements for attaining these objectives. The results and benefits of biotechnology research should be made available to developing countries, as well as provision of financial resources to them to enable them to adopt eco-friendly technologies and goods.

However the recommendations of this Convention met with criticism from both the developed and the developing countries. While the European Commission regarded it as being "too timid", the USA, was not prepared to sign it at all. The USA felt that these recommendations posed a threat to its biotechnology industry, infringing intellectual property rights, and putting American jobs at risk. The developing countries felt that their sovereign right over their own natural resources was at stake. Also while patented rights of industrial companies were enforced, no such protection was ensured for the traditional knowledge and inventions of indigenous peoples and rural communities of Third World countries.

(c) **Forest Principle :** The First World countries made a bid for the control of the tropical forests. Third World countries strongly opposed this move, as it would constitute a loss of sovereignty over their own resources. Also, this was seen as a move by the North to evade its own responsibility of reducing greenhouse gases, and to gain control over the forest wealth of the Third World. As such therefore the Forest Principle could not address any specific problem, nor recommend any specific policy - either economic or ecological. The result was a document without any clear message or direction.

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(d) **Concept and modalities for the implementation of SD - Agenda 21 :** This was a master plan of action for achieving SD, negotiated among 150 nations. Though it is not legally binding, it presented a benchmark against which Government policies on development could be measured. Consisting of 40 chapters and running into 500 pages, the Agenda dealt with basically four themes:-(1) social and economic development, (2) natural resources, fragile ecosystems and related human activities, by-products of industrial production, (3) major groups and (4) means of implementation. Broadly its deliberations can be divided into two parts: one dealing with local level management of resources and ecosystems especially in the Third World countries, and the second, dealing with the reduction of consumption standards, pollution and unsustainable development of the industrialized nations. The Agenda also highlighted the need for safe methods of managing of hazardous wastes including chemical and radioactive wastes, development of alternative technology in energy and biotechnology, and conservation of fragile ecosystems, control and reduction of pollution.

(e) **Role of multilateral agencies such as GATT, UNCTAD :** in dealing with trade and environment had to be clarified. The Agenda acknowledged that "Structural Adjustment Programmes ... have resulted in adverse social and environmental effects." While the market mechanism's role was sought to be reduced, that of Government regulation in environmental protection, effective legal framework and integrated environmental laws, fiscal and economic

policies, were taken as the prime movers to enforce SD. The market mechanism was to play a complementary role, while business houses had to exercise self-regulation as advocated by the International Chamber of Commerce and by the Business Council for Sustainable Development. Also since the implementation of Agenda 21 requires financial resources, the ODA and IDA, were required to give soft loans to the Third World countries to enable them to make the transition to eco-friendly technologies.

(f) **Global Environmental Facility (GEF) :** which was established in 1990 and run by the World Bank, UNEP and UNDP, was listed as the source of funds for projects intended to provide global environmental benefits to developing countries. But the World Bank has a doubtful past of encouraging unsustainable and eco-unfriendly projects in Third World countries. So there was a lot of skepticism about the GEF's efficacy in promoting sustainable development, as it was being sponsored largely by the World Bank.

The need for sustainable development, and measures to protect the environment was accepted by all the participating countries. It was recognized that the present type of development is not beneficial to the environment, and cannot be sustained in the face of depletion of natural resources and pollution.

Check Your Progress - 2

What were the main recommendations of the Convention on Climatic change?

Note : (a) Write your answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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17.7. INTERNATIONAL FINANCE BODIES AND GLOBAL ENVIRONMENTAL CONCERNS

1) **World Bank**, is the largest funding agency to the Third World. It promotes economic development by lending money to fund development projects, under different heads. *The USA* holds 16% of the Bank's capital replenishment, and thus wields the maximum influence over its policies. The Bank usually funds large scale schemes such as water management, power generation and transport infrastructure. These have had serious environmental and social repercussions in the past.

Although the North countries are exporting their eco-unfriendly products and technologies to the Third World, yet they are claiming environmental safeguards for goods imported from the developing countries. Food stuffs for pesticide residues, and textiles for lack of fire resistance (eg. skirts exported from India) were returned on this plea. Hence environmental safe guards are being used as a protectionist shield against the exports of the Third World.

17.9. SUMMARY

In this lesson we have traced the growth of various international institutions on the environment and the various international agreements on environmental protection. We have also examined the importance of these to the Third World, and their relevance to its special problems. The conflicting interests of various blocks in this regard, has also been examined. It was seen that although the need for sustainable development and environmental controls were recognized, the actual policy decisions do not reflect the environmental norms. There is no accord between the environmental regulations flowing from the International Environmental Agreements, and the Economic policy in India based on the Structural Adjustment Programme. Also at the international level, individual countries are more interested in promoting their economic policies, rather than environmental ones. This has further increased the burden on Third World countries, as they have to bear the brunt of the deteriorating environment.

17.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The term "Spaceship earth" was coined by Kenneth Boulding. It signifies the fact that the earth is a self-contained system, dependent on its own finite supply of natural resources, and cannot dispose of its wastes outside of itself. It thus resembles a space ship. It highlights the fact that resources of the world are finite, and that the wastes and pollution created, are again confined to the earth itself. Neither resources can be brought from outside, nor can the pollution be disposed outside the earth.

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2. Climatic changes associated with the depletion of the ozone layer, and of increase in green-house gases, and the need to control and reduce such emissions, were discussed in this Convention. Climatic changes would basically affect the global commons. Developed countries, since they were contributing the maximum to greenhouse gases, were to take the lead to reduce them. Also they had to fund, through the Global Environmental Facility (GEF), the "full agreed incremental costs" of measures taken by the developing countries to shift over to alternative technology. Greenhouse gases such as carbon dioxide, were to be stabilized to 1990 levels by the year 2000 AD, by industrialized countries.

Though this Convention was signed by 143 heads of States, it was weaker than expected as there was resistance from the North and the oil exporting countries, to it. The European Commission agreed to adopt measures to reduce greenhouse gases to 1990 levels, if the USA did so. But the USA refused to comply, and so the whole treaty had to be watered down. It now does not require countries to set specific targets or policy measures to reduce greenhouse gases emission.

17.11. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Briefly enumerate the main features of the Stockholm Conference. How successful was it in promoting international concern for the environment?

2. Evaluate the recommendations of the Rio conference in the context of the needs of developing countries.

3. Discuss the conflict of interests between the developed and the developing countries in environmental protection.

II. Answer the following questions in about 10 lines each.

1. What are the salient features of the Bio-diversity Convention? Are these conducive to the interests of the developing countries?

2. How successful has the World Bank been in the implementation of environmental controls in its development funded projects in Third World countries ?

3. How do the GATT recommendations violate the recommendations of the international agreements on environmental protection?

Dr. Prabha Pant

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UNIT-18 : RESPONSE OF NATIONAL, STATE AND LOCAL GOVERNMENTS

Contents

18.1. Objectives
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18.9. Summary
18.10. Check Your Progress : Model Answers
18.11. Model Examination Questions

18.1. OBJECTIVES

After going through this unit, you will be able to :

* describe why markets are incapable of allotting environmental goods, and the difference between private and social costs and benefits.
* explain various methods used by the governments at the international, national, state and local levels to bring about environmental protection.
* describe the shortcomings of government policy in this respect.
* discuss about various alternative methods that can be used by the government to tackle environmental degradation.

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18.2. INTRODUCTION

Historically, governments have come about to ensure the greatest good for the greatest number of people. However, the role, and the deliverance capacities of the governments depended and continue to be so, on several factors. In the context of concerns for environment and ecology and equity in natural resource usage, it is important to analyze the role of the government in environmental protection, different methods available to the government for implementing environmental control, and also the efficacy of these methods. The role played by the national, State and local governments, in protecting the environment, assumes importance in the current trends of globalization and liberalization. In India, typically, the role of the governments has been as complex as its approaches owing to great many influencing factors. This role evoked different reactions from different sections of the people. Study of the role of the governments generally gets channelised according to the policies and programs of the governments, various instruments adopted, and the efficacy of these instruments. Summarily, the role of the governments has fallen far short of the expectations of the victims of environmental destruction. However, this failure of response from the governments has

been due to several problems, generally attributed to the complexity of the Indian social scenario. Not only the environment policy of the governments, but also polices for agriculture, forests, industries, export and trade, as also the overall development strategy, do not address the environmental concerns. This chapter will look into the problems and shortcomings of the government's environmental policy versus its other policies such as the industrial, agricultural and foreign policies.

18.3. ENVIRONMENTAL PROTECTION AND MARKET FORCES

Market forces, or forces in the non-governmental domain of trade, are by basic nature aim for maximization of limited objectives and of prioritization. By this very nature, they cannot ensure protection of environment. There is a school of thought which holds to the point of view that environmental protection and conservation cannot be achieved through market forces. This is because the market deals only with private costs and benefits. It excludes public and social costs and benefits, which also include environmental costs and benefits.

Private Costs are those borne by the individual unit in question. For eg. a firm manufacturing pesticides, pays for its inputs of raw materials, labour charges, interest, rent etc. It buys these from other markets. In turn, it sells its output in a market, and receives revenue. The buyer uses the pesticide; the benefits of the consumption accrue to him alone. Thus costs and benefits are 'private', and are borne entirely by the buyer and the seller, through the market. Private costs are therefore internal to the economic unit considered.

Exchange thus takes place only in the market, sellers bear the internal costs of production, and enjoy the profits that they make after selling the product. Buyers pay the price of the product, and enjoy the benefits of its consumption. It has to be remembered that all economic units (buyers and sellers) are independent units. There is no interdependence outside the market.

Also, for direct exchange to take place in the market, it is necessary that the commodity be priced. This then is another characteristic of the market. Pricing is possible only if the good or service is owned by someone - individuals, groups or the Government. Goods that are not owned by anyone, cannot be priced.

The goods and services that enter the market should also display the property of 'exclusibility'. This means that if one economic unit uses (for production, or for consumption), any commodity or service, then this is not available to others for use. For eg. a consumer drinks a can of Coke, then the same Coke is not available to others. The producer who uses electricity, has exclusive use of it, the same unit of electricity cannot be used by others.

The market deals only with the demand and supply of the present generation, at a given moment of time. Requirements of the future generations are not taken into account.

Social Costs and Benefits : Environmental goods do not satisfy the criteria required to be allocated through a market. In the first place, environmental goods such as the atmosphere, the seas and rivers, are not owned by anybody. Hence their use cannot be priced - they are free. This has resulted in their misuse, since there is no price for polluting the atmosphere or the seas. The producer of pesticides, does not have to pay for the effluents that he releases into the sea or into a nearby river or lake. Nor does he pay for the smoke and air pollution that he is causing. These costs are 'external' to him. Similarly, the consumer does not pay for the effect the pesticide would have on the environment. As is well known, the toxic effects of non-biodegradable pesticides

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remain for long in the environment. This could harm useful insects such as butterflies, bees, earth-worms etc., and in turn the birds, lizards, frogs, etc. that consume these insects. Now all these creatures are important bio-controls of pests. At the same time the pesticides may leach into ground, water bodies, and those consuming this water, will feel the adverse effects on their health. But the polluter does not pay for these costs that he is inflicting on the environment. These costs are external to him. Such external costs are called 'social' costs or 'externalities', they are costs imposed by the economic unit to others for which no payment is made. The polluters only pay for the commodities that they buy, they do not pay for the harm that they are imposing on others by their pollution.

There is interdependence outside the market. The costs that are imposed through pollution and resource depletion, are not paid in the market. The economic units interact outside the market, unlike economic goods which are exchanged in the market.

Since environmental goods are not owned by anybody, they have no price, there is no market for these goods. For eg. what is the price of air available for pollution? There is no answer to this, as air is free.

Thirdly, environmental goods do not satisfy the property of 'exclusibility'. If one firm pollutes the air, others can do so too. The first firm cannot prevent others from polluting the air, when it itself makes use of this facility. Also, if one person is affected by pollution, all the people in that locality are affected. This applies to resource depletion as well. When the fish stocks are depleted, the entire fishing community is affected. It is not possible to exclude others from environmental degradation, or use.

Again unlike private goods, environmental goods for future generations, will have to be considered. If the air is polluted by this generation, the future generations will suffer. For instance, the depletion of the ozone layer by the present generation spells disaster to future generations, who will have to bear the cost of increase in the inflow of ultraviolet rays, that could cause climatic changes, leading to rise in sea levels and submergence of coastlines and islands, increased risk of cataract and skin cancers, etc.

In the case of common property resources also, the market is incapable of efficient allocation. For eg. fish stocks in the open sea - have no ownership, display no exclusibility, nor can they be priced. (What is the price of fish swimming in the oceans? They are priced only after they are caught and brought to the market). The same applies to forests and mines. Here, over exploitation will deplete resources. The present generation enjoys the benefits at the cost of the future generations.

The market thus cannot handle environmental goods, and economists refer to such conditions as 'market failure' since the market is incapable of handling such situations. If left to market forces, depletion and pollution cannot be controlled. And the environment continues to deteriorate, since those who pollute do not pay for it, nor do those who deplete resources pay for the depletion. Hence it is necessary for a regulatory body, such as the Government to undertake environmental protection.

Check Your Progress - 1

What are 'private' goods? How do they differ from 'social' goods?

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Note : (a) Write your answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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18.4. THE ROLE OF GOVERNMENT

Since the market is incapable of optimally allocating environmental goods, it is necessary for the government to ensure that the environment is protected. This can be done through : (a) legislation, (b) fiats and (c) fiscal policy.

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a) Legislation on environmental protection was introduced in most countries after the Stockholm Conference of 1972. We shall look into the role of the government in the conservation of the environment in India, in the next section.

b) Governments can issue fiats or directives to firms or individuals to undertake environmental protection. For eg. pollution checks on vehicles and compulsory smoke emissions can be imposed. Ban on various environmentally harmful activities - such as the import of hazardous wastes, or ban on the production and consumption of certain goods that are environmentally harmful, can be imposed through government order or directive.

c) Fiscal policy can also be used to penalize environmental offenders, and to encourage environmental friendly activities. For instance, taxes may be imposed on polluting firms, or on those exploiting scarce resources. The tax is a way of internalizing the externality, and the increase in costs, may force the offender to take up corrective action. Also encouragement to eco-friendly products and processes can be taken up. For instance, subsidies can be given to solar cookers and energy, or to 'green' refrigerators that do not emit harmful CFCs. Another method is for governments to popularize and educate the public about the harm being done to environment by certain activities, and to promote environmentally benign activities and alternative technologies.

Check Your Progress - 2

What are the different methods available to the Government for environmental protection ?

Note : (a) Write your answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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18.5. GOVERNMENT'S ROLE IN ENVIRONMENTAL PROTECTION IN INDIA

Government's concern over the conservation of the environment, ranges from the international, national, and state to the local levels

a) **International level :** International agreements on various aspects of environmental protection have been drafted since the 1970s. For instance, the Convention on the control of emissions of greenhouse gases, on export of hazardous wastes, and the various treaties signed at Rio and subsequent conferences, call for global management of the environment.

and for taking up global measures for conservation and protection of the environment. Governments represent their countries in these Conferences, and try to protect the interests of their own countries in the ensuing debates. For instance, since the maximum pollution and environmental degradation is being caused by the so-called advanced or industrial countries, the Third World countries' Governments, argue that the task of cleaning up the environment also depends on them. Such debates and arguments, finally lead to some consensus on what is acceptable to all, and international agreements are then drawn up. Based on these international agreements, the governments of individual countries impose their legislation and controls over environmental degradation in their own countries.

b) **National level :** In India, the first Act on the Environment was the Water (Prevention and Control of Pollution) Act of 1974. This was followed by the Water (Prevention and Control of Pollution) Cess Act of 1977. In 1980, a separate Department of Environment was created to carry out environmental appraisals of development projects. The Air (Prevention and Control of Pollution) Act of 1981, addressed itself to air pollution and its control. After the Bhopal tragedy, the environmental restrictions were further tightened through the passing of the Environmental Protection Act (EPA) of 1986.

The EPA had a far wider reach than the earlier Acts. It could, for instance, prosecute the firms that did not abide by the conditions of the Act. The Ministry of Forests and Environment (MEF), was given the power to close down polluting units that discharged untreated effluents. Individuals were also permitted to initiate action against anyone violating the Act, after they had informed the State Pollution Control Boards.

In 1994, the Government of India introduced a notification by which environmental clearance had to be obtained from the MEF, by all new projects, and for expanding and modernization of existing ones. The major projects now have to submit an Environmental Impact Assessment report, as well as an Environmental Management Plan to the Ministry. Twenty-nine types of industries with individual investment of over Rs.50 crores, come under its purview. These industries have to submit a detailed account of the impact of their activity on the environment, in terms of air pollution, effluents released, noise pollution, impact on tree cover, on human settlements etc. A report on the pollution treatment that they are to undertake, has also to be submitted to the MEF.

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c) **State Level Control :** Although the Environmental Protection Acts have been passed at the National level, their implementation rests with the States - more specifically by their Pollution Control Boards (PCBs). This however has caused a number of problems, since the State Governments feel that excessive environmental protection is at the cost of modernization of their States. We shall look into these problems a little further on in this lesson.

d) **Local Level Management :** Local bodies such as the panchayats, the village level organizations, and local voluntary organizations, are increasingly playing an important part in environmental protection. This is because, although the laws are enacted at the Central level, the impact of environmental decay is experienced at the local level. Also the locals have a better understanding of their own problems and their own priorities. The role of the local people, is therefore more befitting to environmental preservation, since they are on the spot and can monitor the activities of the polluting or depleting bodies.

e) **Judiciary :** Although there are a number of laws on the preservation of the environment, their actual implementation is not satisfactory. In India, the people are able to tackle their

environmental problems only through the judiciary process. The courts, especially the Supreme Court, have become increasingly the medium through which those affected by environmental degradation, seek to redress their sufferings. In this connection, the courts order the closure of polluting industries, institute enquiry committees on environmentally degrading activities, and make arrangements for the payment of compensation to the affected population.

18.6. EVALUATION OF GOVERNMENT'S ROLE IN ENVIRONMENTAL PROTECTION IN INDIA

Environmental protection has two dimensions - control of pollution, and reduction of resource depletion, and their consequences. In India, laws on pollution are fairly comprehensive, but there are no laws on resource depletion - of both renewable and non-renewable resources. In fact, there is no comprehensive Environmental Policy, nor is there any move towards Sustainable Development in either the Plan documents nor in the Economic Policy of the Government, incorporating environmental conservation with development. As a result, the environment considerations are usually addressed and tackled only when there is public outcry against any development project.

Although regulatory controls have increased, environmental quality has not improved. This is the result of a number of factors, which include absence of basic infrastructure, over reliance on litigation, absence of comprehensive industrial location policy, inadequate use of economic instruments, poor commitment at the corporate level of management, and absence of relevant technology.

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The implementation of both the Air and Water Acts has been extremely slow. The implementation of the Environmental Acts is not effective, because of procedural inadequacies. The Pollution Control Boards (PCBs), are the regulatory bodies, but because of the provisions of the Acts, they are unable to enforce strict control. This is because they have to provide proof of pollution in the courts. The number of cases pending in courts for non-compliance of environmental regulations, is very high. In the whole of India, around 3500 cases of non-compliance where pending since 1993. This is because non-compliance is taken as a criminal offense, and the Pollution Control Boards have to rely on litigation for enforcement of the Anti-Pollution Laws. This procedure is both time consuming and inefficient, since the PCBs do not have the infrastructure for examining pollution standards of the industrial units. Also the approach of command and control, requires a large staff. The regulatory expense burden is high on the controlling agency, as the onus of proof is on the regulatory agency. It is also difficult to assess the quantum of discharges or effluents, and its quality from each unit, without a comprehensive environmental monitoring and inspection system. Regulation is envisaged as a centralized controlling factor, rather than on-line monitoring and self-regulation by the polluting units.

Even when environmental controls are implemented, only the new units can undertake pollution control and treatment. Plants set up before 1985, do not have the space to fit in environmental protection equipment, and because of vintage and process design problems, retrofitting is not possible. Thus old plants are virtually outside the scope of environmental standards.

Environmental controls are also difficult to implement in small and medium units. Tanneries, sugar industries, paper and pulp, distilleries, drug and chemical firms, textiles, etc. are often set up in the small and medium sectors, for which compliance ratio (number of units complying with emission and effluent standards), is less than 50% at the all-India level. Even when such units are given

closure notices, they usually get a stay order from the courts, and continue their activities. Yet another difficulty, is the dispersion of small units over the country.

Those industries that do have polluting controlling equipment, do not always use them, since this increases their costs. Nor is the EIA very effective. Since the environmental monitoring infrastructure of the State governments is very poor, even if an EIA report is submitted, the States cannot close down projects giving wrong information about their activities. And the May, 1994, amendment gave discretionary powers to the Environmental Ministry to disregard experts, environmental groups and the protests of the affected people against any new projects.
Some industries have also been given licenses, without the formality of submitting their EIA report. With the present change of government at the Centre, and its commitment to liberalization, and globalization of the Indian economy, it is doubtful whether environmental problems will now be considered seriously.

In cases where the party forming the government at the State level is different from that at the Centre. there is resistance to environmental protection. Many of the provisions (such as water) are State subjects, with which the Central government cannot interfere. Also the political parties change their policies once they form the government. The case of Enron illustrates such a *volte-face* by the present government of Maharashtra.

Lack of consensus among different ministries is yet another reason why environmental protection has not been successful in India. The Industrial, Agricultural, Finance, Foreign, Power, and Planning Ministries, are more powerful, and manage to circumvent or even thwart the efforts at environmental protection. Also in the bid for globalization, multinational firms are being encouraged without taking proper steps to determine if their products and processes are environmentally safe or not.

The Bureaucratization of the implementation of the environmental laws, has also contributed to their inefficacy. Most of the bureaucrats are untrained in environmental matters, and hence cannot take decisions on environmental degradation that is taking place at local levels. Also the amount of red-tape involved discourages those suffering from the environmental degradation from approaching the authorities for help and redress of their grievances.

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Other factors that lead to the ineffectiveness of environmental protection in India, are corruption, favoritism, protection to degrading units given by powerful and influential groups and individuals. Also general apathy on the part of the public, ignorance of the ill-effects of environmental degradation, lack of civic sense and commitment - all contribute to the poor implementation of the environmental laws.

18.7. EFFICIENCY OF LOCAL BODIES IN ENVIRONMENTAL PROTECTION

Environmental management at the local level, is very important, since environmental degradation has its immediate impact on local settlements. To a large extent, the environmental movement was initiated by agitations of local settlements, that were hard hit by the environmental degradation caused by various projects. Also, the ultimate effect of the environmental laws are felt at the local levels, and their non-implementation imposes extra burden on them. Hence they are interested in ensuring that the environment is not degraded, and their source of livelihood, their cultures, traditions and crafts, are not destroyed.

Although local governments are also bogged down by bureaucratic procedures, they are still more efficient than the State and National governments, since they are directly accountable to the local population. Also, there is a better interaction of gram panchayats and the people, and less of red tape involved. The leaders of the masses understand and also experience the same problems. The need for environmental protection is felt because they realize the direct link between their livelihood and the environment.

However, the environmental laws enacted in India, do not give any importance to the role of the local governments or to the local people. This is because, while the laws on pollution affect the polluting unit, those on natural resources completely ignore the local population. For instance, the 'Project Tiger' sanctuaries, do not allow local grazers and tribals into these forests, although they have been denizens of these forests for many generations. No alternative land for grazing and for occupation was given to them. Thus, forests which provide food, fodder and fuel to local communities, are being increasingly brought under bureaucratic controls. Unfortunately, while the bureaucrats do not permit the local people from using forest resources, they permit lumber merchants, pulp and paper industries, to fell trees and to clear forests. In this regard, the Chipko movement, where illiterate villagers were able to repel the cutting down of trees, shows that local level resistance to environmental degradation, is often successful.

With greater unity of purpose and willingness to fight, and with the support of voluntary agencies, the local movements have a far more successful record in environmental protection. Local movements have been able to tackle large corporate giants, and influential persons at national and international levels.

More positively, when the government of the State or the Centre, have been unable to provide succor or prevent degradation, the local level governments, have been predominantly been successful in achieving the goals. Local movements for the preservation of water, for protecting forests and bio-diversity, local irrigation of recycling wastes, and protests against large degrading developmental projects such as dams, mining, etc. have triumphed over bureaucratic controls.

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Even in the case of management of natural resources, the local level management, has been more effective. This is because the locals are directly affected by the environment, and there is a symbiotic relationship with it. For instance, tribals in forests are aware of the need for the conservation of forests, since their livelihood depends on forest products. However, a timber merchant will not have the same commitment to conservation, since he can always move over and cut down another forest when the first forest is razed to the ground. Local fishermen, agriculturists, shepherds and cowherds, tribals, and villagers have a greater stake in the conservation of their environmental resources. This commitment ensures that these resources are managed in a sustainable manner.

Check Your Progress - 3

Why are people's movements for the preservation of the environment more successful than the policies of the Central Government?

Note : (a) Write your answer in the space provided below.

(b) Compare your answer with the one given at the end of this unit.

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18.8. OTHER METHODS TO ENSURE ENVIRONMENTAL PROTECTION

Environmental management by the government should encompass two areas - pollution and natural resource management. The methods used by the Government of India have not been very effective. This is the result of both the limited scope of environmental regulations, and inefficiency in their implementation.

Pollution is managed through regulatory control. This has increased the costs of the regulatory bodies, and made them inefficient. If economic instruments were also included, and the responsibility of controlling pollution placed on the polluter, then better efficiency could be achieved. The present setup envisages a command and control approach rather than market-based instruments.

Commands to reduce pollution have not been as effective, as economic controls - such as taxing the polluter to the extent of the pollution that he is causing. The effects of environment damage-related charges, or emission taxes would provide a more effective route to the same ambient quality. As seen earlier in this lesson, firms react only to private costs. Hence if the externalities are

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internalized through taxes, the reaction of the firms will be more immediate. Only if the "Polluter Pays" principle is adopted, will polluting units respond at once, because taking up pollution control will be less expensive than the taxes on pollution. Self-regulation by polluting units, can be more effective if the units are made accountable for their pollution.

In the case of natural resource management, the scope of operations is much wider and more difficult. Any piece-meal solution, will not be successful, since systems overlap. A more comprehensive legislation on management of natural resources is required, to be implemented at the National, State and Local levels. The opportunity costs of resource depletion, in terms of other forms of employment being affected, should also be taken into consideration. For example, setting up of prawn farms, affects farmers, fishermen, and reduces sources of fresh water. These aspects are usually ignored, and short-sighted policies are implemented.

To avoid the piece-meal approach to environmental management, the economic policies of the government should be oriented towards sustainable development. Environmental degradation is the result of the present type of economic development, and the type of technology being used. It is not possible for environmental protection to be implemented, when the economic policies are themselves environmentally harmful. For instance, if the government keeps giving licenses to pesticides industries, which produce banned pesticides, then merely tinkering at the margin to control pollution is not the solution. Such goods should not be allowed to be produced in the first place, and in the second, organic and bio-pesticides should be encouraged. This will ensure a more sustainable approach to the pesticide industry. The same type of approach has to be followed in other cases also.

The concept and modalities of sustainable development, should be central to the economic policies of the government. Unfortunately, sustainable development does not form the core of the any of the economic policies nor of the Five Year Plans. In such a situation, mere environmental regulations will not be successful in protecting the environment.

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18.9. SUMMARY

This lesson gives a brief account of the environmental laws and regulations imposed by the government at different levels. It also enquiries into the efficacy of these laws, and their shortcomings. The role of the local governments and the people movements have been examined, as well as the alternative methods available to the governments to ensure environmental protection.

18.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. Private goods display the following properties : i) they are owned by somebody, ii) they can be priced, iii) there is a market for them, wherein they can be bought and sold, iv) they are exclusive in use, i.e. if one person uses them, others cannot, v) the costs and benefits are internal to the economic unit and vi) the entire analysis applies to the present generation only.

   In contrast, social goods are i) not owned by anybody, ii) cannot be priced, iii) there is no market for them, iv) they are not exclusive in use, as one person using the facility or the cost, cannot exclude others from doing the same, v) the costs and benefits are external to the economic unit, and vi) the future generations are affected by the actions of the present generation.

2. The Government can protect the environment through a) legislation, b) through directives and fiats, and c) through fiscal policy. In the first case, environmental laws are passed, and compliance by the concerned unit is mandatory. Here the government implements the laws through regulatory methods. Directives and fiats call for ban on certain activities and products, and are employed as the need arises. Fiscal policy instruments include the use of taxes on pollution, and subsidies to encourage eco-friendly products and processes.

3. People's movements are generally more successful in environmental control, because of the greater commitment that they have for environmental preservation. The government policy is usually bogged down by inefficiency, corruption, favoritism, bureaucratic regulations, and even pressures from various influential groups. This leads to either non-implementation of the various laws, or to their breach by the polluting units. People's movements focus attention on such cases, and they are able to move either the government or the courts to redress their grievances. The local people realize their links with environmental resources, and are more committed and careful about environmental protection.

18.11. MODEL EXAMINATION QUESTIONS

I. Answer the following qustions in about 30 lines each.

1) What is meant by "market failure" ? Why does it occur in the case of environmental goods?

2) What are the factors that have impeded the implementation of environmental laws in India?

3) What are the other methods available to the government for environmental protection. Why have they not been implemented?

II. Answer the following questions in about 10 lines each.

1) How are national policies on the environment affected by international environmental agreements?

2) Discuss the clash of interests between the State and the Central Government, in environmental protection.

3) Show how the "Polluter Pays Principle" can be used to ensure that environmental quality is maintained?

Dr. Prabha Pant

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UNIT-19 : GREEN MOVEMENTS

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19.1. OBJECTIVES

After going through this unit, you will be able to :

* explain the growing politics of environment,
* describe the concepts behind environmental protests,
* discuss about environmental destruction at the cost of local community interests,
* explain the work of groups and organisations for a new direction of sustainable development and policy making.

19.2. INTRODUCTION

Environment movements in the modern sense began in the West. But over the last two decades, it has spread far and wide even in the so-called Third world. It has already taken deep roots in India. Everybody has now begun to talk about environment, including those governments and administrations which are responsible for its destruction and those multinational corporations which make use of the resources of the developing world for their own production and in the process destroy the environment.

Many environmental groups and organizations have been working on varied issues in order to give a new direction to development through the protection of environment. There are numerous local protests against land being submerged by large dams, against pollution of water courses, rivers,

lakes, and fields, against lakes being encroached, against developmental diseases and lifestyles and against mining activity bespoiling farming land. Much of this efforts are being aided by a different breed of scientists and academics who identify themselves with the problems and aspirations of the people and attempt to find the scientific evidence needed to back up these aspirations.

Environment protection as such is not the entire concern for most of these groups. Their main concern is about the use of the environment: how should the environment be used and who should use it and benefit from it. The biggest problem is, as these groups perceive, that modern development misplaces the priorities of the local people, and is not people-centered. The marginalised, last person remains in a state of tremendous suffocation because his or her voice is never listened to by anybody and the number of such people in the country is very, very large. For sustainable development, it is very important that their voices are strengthened and brought forward.

To cite a few examples, there have been people's protests in many parts of the country against the conversion of oak forests into pine forests and of sal forests into teak forests. Neither pine nor teak is of any interest to local communities. In the Singbhum area of Bihar, there is even a movement to destroy the new teak forests. Equally, there was a strong protest in Karnataka against the planting of Eucalyptus on farmers fields even on so-called barren fields. This is an example of adverse biomass conversion, harmful for the people, promoted by modernization - poor people are deprived of firewood for their daily cooking purposes. There has been a movement against indiscriminate spread of aquaculture in the ecologically-sensitive coastal areas. Campaign against Konkan railway project was spectacular, but failed to prevent the project from being implemented. Also, several actions of government like allowing for construction within 500 meters of seashore was protested against, and the government was forced to withdraw. A multinational company, Dunlop, had to shift its proposed Nylon 6-6 plant from Goa to Tamilnadu, following popular protests.

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A movement by Buddhist monks in Thailand against deforestation was done in a novel way - tying saffron robes to the tree trunks. Since saffron robe indicates sacred characteristics, they wanted to convey the message that forests are as inviolable as any sacred object. Closer still, in Andhra Pradesh, there have been movements against industrial pollution in Patancheru and other industrial in the surroundings of Hyderabad. Uniquely, an anti-nuclear movement against the setting up of proposed nuclear power plant at Nagarjunasagar hydel project was largely successful in achieving its goal.

Most of the movements in contrast to political agitations were peaceful, and were creative in achieving their respective objectives. Thus, the form of the movements was varied and different ranging from demonstrations, protests, silent marches, post card campaigns, memorandum presentations, court cases, awareness activities (books, pamphlets, etc.) and utilization of media.

Unfortunately, most movements have not been documented and/or analyzed properly. With the result comprehensive information is lacking. Hence, only a few movements have been presented here to give the student a general idea of how environmental issues are being tested in the political arena. Almost all the movements have questioned the path and the direction of change and development, and have advocated sustainable development as an alternative.

It is this growing understanding of the relationship between the people and their environment, borne out of a concern for a more equitable and sustainable use of the environment, that is probably the most important development in India in this decade.

19.3. SILENT VALLEY MOVEMENT

A dam, Silent Valley project, was to be built on the Kundhipuzha river, in the Palghat district of Kerala. It was to produce240 MW of power, irrigate 10,000 ha of additional agricultural land, and provide employment to 2,000 to 3,000 people. Although, the project was conceived in 1963, there was delay in its execution for want of finances. In 1976, a task force on the project suggested that this area ought to be preserved. Later on, the Kerala Shastra Sahitya Parishad, a non-governmental organization working on science education, deputed a multi-disciplinary team consisting of a biologist, a nuclear physicist, an electrical engineer, an economist and an agricultural scientist, to study the feasibility and impact of this project. This team prepared a Report, "The Silent Valley Hydro-electric Project : A Techno-economic and Socio-political Assessment".

According to this project, if the dam were to be built, the first calamity would be the forests. Apart from inundation, large tracts of forest area would have to be surrendered to the Electricity Board, who would clear them to build quarters for their employees. Thus, forest devastation would begin even before the dam came up. Then submergence would have deleterious effects like destruction of shoreline, riverine vegetation and the disappearance of several valuable species of flora and fauna.

Following this adverse report, a nation-wide campaign was launched to save the Silent Valley. 'Save Silent Valley' groups were started in various states and several NGOs within Kerala joined hands. KSSP spearheaded this struggle. Scientists, research workers, intellectuals and youth supported the campaign, which was resisted by the KSEB and the state government. Ultimately, the execution of the project was abandoned based on a report submitted by a joint committee headed by Prof.M.G.K.Menon. And the Silent Valley was declared a national park.

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This movement, first of its kind in India, brought to the fore the following considerations :

1. There is a difference between academic knowledge and the day to day experiences of the people.

2. Alternatives have to be considered, and publicized to protest against a particular option. Kerala state government and the Kerala State Electricity Board (KSEB) based their propaganda on the fact that the dam would provide electricity, irrigation and jobs, and the people in the adjoining districts firmly believed that the Silent Valley project would be the panacea for all their ills. It was suggested that this project would be located at the northern end of the state, which was suffering from an acute power shortage.

However, the Silent Valley project was located in the middle of the State, and would not be able to solve the problems of the north. Also, at that time Kerala was selling power to Tamil Nadu and Karnataka, i.e., it was producing surplus power. Based on these two points, KSSP pointed out that if the state can transmit electricity to other states, why can it not transmit power to the north? The Electricity Board had no answer to this. So people began to look at the wires passing overhead, and they started to ask themselves, if electricity can flow over our heads, why can it not flow here too? It was a similar case with irrigation too and jobs.

This movement is a very good example of how certain short sighted activities could have turned to be detrimental to people's subsistence. The campaign was led by local people and they got it

stopped. In the initial stages, none of the local people believed that a dam could possibly have any bad affects. It was Kerala Shastra Sahitya Parishad (KSSP) which made the local people realize the value of a gene pool, and the fact that the forest was a reservoir of genes. In this pursuit, both the human and the bio-physical dimension of our environment had been taken into account.

Check Your Progress - 1 & 2

1 Where was the Silent Vally Project proposed?

2. What are the important reasons for the abandonment of Silent Vally Project?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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19.4. CHIPKO MOVEMENT

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Ecological balance and traditional human relations with forests are so intertwined that it is difficult to see them separately. Destruction of forests has degraded not only the natural environment but also the daily life of the villagers. Declining area under forests and the inability of the forest department to conserve forests resulted in the birth of Chipko Andolan.

The local economically backward people of Uttarkhand region, in Uttar Pradesh, raised their voice for the first time through the Chipko movement, to say that their life is mainly dependent on forests.

In 1960's, under a working plan, trees were cut on a large scale. This deforestation deprived the local people of the firewood sources for their cooking purposes. Women had to increasingly walk miles in search of broken branches, and twigs in the forests. Proportionately, the intensity of the floods in the Alakananda river increased in 1970 sweeping away six bridges, 16 foot bridges and 25 buses due to soil erosion and siltation of streams, rivulets and rivers. More than Rs.10 million was spent on desilting the Upper Ganga canal and several millions of rupees worth of direct and indirect damage took place. On the other hand, the exploitation of forests yielded an income of Rs.10 lakh over the entire decade. Between 1973 and 1977, the people of Chamoli district protested at least half a dozen times against the mismanagement of the forests by the Forest Department.

Following the Chipko Andolan in Reni, where the women took to the unique way of protest by embracing the trees whenever the contractors approached them to cut down, a committee of experts under Dr. Virendra Kumar, studied the problem. This Committee agreed that the issues raised by the villagers were significantly correct, and forest management based on the so-called

Forest Science was wrong. On the one hand, the forest conservation policy of the government allows the sale of forest produce in international markets and metropolitan centres at competitive prices. On the other, people living in forests have lost their rights to utilise the forest produce for their livelihood.

The Working Plans of the Forest Department, based on this approach, were challenged by the ordinary villagers. Chipko leaders believed that the only way out is to create awareness among people and that their interests coincide with those of the forests themselves. People realized that the forests are the basic foundations of their living standards, and their survival will be at stake once the forests disappear. Women became partners in the protection and the development of forest wealth because they were the prime victims of this destruction. For this reason, Chipko Andolan has always seen women at the forefront.

This brought the Chipko Andolan to the notice of environmentalists and the government and it is today known in many parts of the world. The Andolan, which started by saving the forests, continues to insist on the need for conservation of forests and draws the attention of the government towards it.

Development of Peoples Consciousness

In their bid to save their forests in 1974, the women of Reni village, situated in an extremely sensitive region of the Alakananda catchment, had called their forests their "mothers home" (mayaka). In the same way, in 1975, 200 women from Gopeshwar waged a struggle against the district authorities to save their oak trees. Later, the women of Bhyundar village, situated in the lower reaches of the world famous valley of flowers, had also launched their Chipko movement. In 1980, the women of Dungri and Paitoli villages, situated in an extremely remote region of Chamoli, had also launched Chipko.

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Dasholi Gram Swarajya Mandal was associated with this movement significantly. Following are its experiences :

* Psychology of the villagers was taken into consideration.
* Created awareness among the people about the importance of forests and peoples participation in afforestation and conservation.
* Organized eco-development camps in seriously affected areas.
* Educational discussions were held.
* People started planting trees as their contribution.
* Nurseries were raised and improved chulhas (for efficient burning of firewood) were built.
* Soil erosion in the fields was prevented by constructing stone walls. In the space between the walls and the fields, grass, fuel fodder and fruit trees were planted.
* People from different walks of life were actively involved in planning and implementation of the programmes.

19.5. NATIONAL TEST RANGE AT BALIAPAL, ORISSA

This National Test Range (NTR) was planned to be set up on the coast of the Bay of Bengal in 126 villages of Baliapal and Bhogarai blocks in Balasore district of Orissa, spread over 400 sq.kms. Establishment of this Missile Base necessitates the evacuation of more than 1 lakh people. This area is the most fertile landscape in an otherwise backward state like Orissa, and is famous for its betel leaves, meat, fish, vegetables, paddy, cashew nuts, and many other produces.

Fearing the displacement, villagers launched their protests against the project. The whole people of Baliapal unitedly took the protests to such an extent as to obstruct the entrance of the district Collector into the region under leadership of Khepanastra Ghati Birodhi Committee, a notable example in the history of mass movements in post Independent India. The government is offering massive rehabilitation measures including model villages to be set up with 500 sq.yards for each family free of cost, and financial assistance for house construction and building other infrastructure. The entire rehabilitation package costs more than Rs.400 crores. However, the villagers were not to be convinced. Basically, the government did not take the people into confidence while planning the Range. Also, villagers are unwilling to lose their traditional homes and living environment, and established lifestyle. Further, there is no confidence among the people over the government, about fulfilling its promises, in the light of experience elsewhere wherever such displacement was forced on people.

This movement of the people was joined by civil rights activists, sociologists, academics, NGOs and environmentalists. However, political leaders have been using this issue to further their interests, dilly dallying, sometimes opposing and other time supporting the National Test Range. But the people have not withdrawn their protests and resistance even an inch. This was one movement which had spontaneity, without any political group or organization having any role in its initial stages. Even now organized groups and organizations are only at the periphery of this movement.

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19.6. NARMADA CONTROVERSY

On the 312 Km long Narmada river, government had planned to build some 30 big, 300 medium, and 3000 small dams. This is known as the country's largest river valley project. The area to be affected by this project is spread over in the States of Madhya Pradesh, Maharashtra and Gujarat. The idea of the project was conceived long back. However, the implementation was complicated by the fact that the river passes through three states, which could not agree upon division of project costs and the benefits. In 1969, the dispute was referred to the Narmada Water Disputes Tribunal, established under India's Interstate Water Disputes Act, 1956. In 1979, the tribunal handed down its award. The Tribunal, by agreement of the states, for the purpose of distribution of benefits accepted the figure of 28 million acre feet as the annual water yield from the Narmada with 75 percent dependability, to be shared by Madhya Pradesh, Maharashtra, Gujarat and Rajasthan - Gujarat's share is 9 m.a.f and that of Rajashthan 0.5 m.a.f. The Sardar Sarovar dam, one component of the entire project, is meant to divert water to users in Gujarat and Rajasthan: their share of the Narmada water.

The Sardar Sarovar Projects are intended to bring drinking water to Kutch and other drought-prone regions of Gujarat, and to irrigate a vast area of the state as well as two districts of Rajasthan. This requires a large reservoir on the Narmada river and an extensive canal and irrigation system. The dam, under construction on the Narmada river, at Navagam and Kevadia, will impound water

to a full reservoir level of 455 feet. It will submerge 37,000 hectares of land in three states: Gujarat, Maharashtra, and Madhya Pradesh.

The impact of the Sardar Sarovar project extends over a vast area and affects a very large number of people, most of whom are tribals. At least 100,000 people, in 245 villages, live in the area affected by submergence. In addition to the 100,000 people living in these villages in the submergence area, there are likely to be 140,000 farmers who will be affected by the canal and irrigation system. Finally, there are the people living downstream, below the dam, numbering thousands more, whose lives will be significantly affected. In 1985, the World Bank agreed to lend a total of $450 million for these projects. This immense development and the World Bank's role in it have become the focus of heated controversy.

In 1985, when the credit and loan agreements were signed, no one knew the scale of displacement that would result from the Sardar Sarovar Projects, nor did anyone have anything like a picture of the people who were to be displaced, nor had the people themselves been consulted. The back water effect of sedimentation at the upstream of the dam is also an issue which has been ignored. In fact, resettlement policies for Sardar Sarovar, both those of the states and to a great extent those of the Bank, have been based on the measures set out in the 1979 Tribunal award. But the award sought mainly to adjudicate an interstate dispute. It did not, and should not have been expected to, design policies that would meet the needs of the affected people of the projects as a whole. It did not even mention the Gujarat oustee, nor did it take into account the cultural attributes of the oustee population; in the award there is no discussion of tribal people's, or of the real meaning of "landlessness". There was no adequate resettlement plan, with the result that human costs could not be included as part of the equation.

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In 1990, the Bank announced a comprehensive resettlement policy applying to oustees generally, and in 1991 a specific resettlement policy relating to tribals. The Government of Gujarat and the Government of Madhya Pradesh and Maharashtra contend that Gujarat's policy goes beyond the requirements set out in the Tribunal award and the Bank agreements. Maharashtra, with 3,000 families to be resettled, and Madhya Pradesh, with as many as 23,000 families to be resettled, were prepared to offer two hectares of land to landed oustees. But they are not willing to provide two hectares for sons of the family who are majors. Neither Madhya Pradesh nor Maharashtra had acknowledged any right of displaced people to adequate land on resettlement.

In Madhya Pradesh, virtually no steps were taken towards resettlement and rehabilitation. In Maharashtra there are 33 submergence villages divided between two talukas or districts - Akkalkuwa and Akrani. Resettlement and rehabilitation in Maharashtra are beset by serious difficulties. Maharashtra's policies fails to provide adequate land to the displaced families. Significantly, none of the 24 Akrani villages are deemed by the Maharashtra government to have any revenue land. Thus, they can only qualify for encroacher status, with one-acre land benefits. The only resettlement policy applicable to three states is the World Bank's Policy. But Bank policy has not been respected. The projects were not appraised in accordance with the Bank requirements. Basic information had not been gathered and adequate plans for resettlement and rehabilitation were not in place.

There is a close connection between the engineering designs and the human and environmental impacts. The various parts of the projects were described as death traps, taking malaria to the doorsteps of the villagers and creating ideal breeding sites for malarial mosquitoes. The failure to anticipate and prevent malarial hazards is a part of the failure to implement measures to mitigate the impacts of the Projects.

Both the 1982 and 1991 policy directives emphasize the importance of detailed research into the social, economic, and cultural implications of projects that impinge on tribal people's lives and lands. It is no wonder that the status of the people of the Narmada valley has been the subject of many arguments. In April 1987, in response to mounting pressure to examine what was happening to implementation of resettlement policies for these Projects, the Bank sent it's largest ever mission to the region.

In 1991, the World Bank appointed Mr.Bradford Morse to organize an independent review of the measures being taken to mitigate the human and environmental impacts of the Sardar Sarovar projects. The saga of the controversial Narmada project had continued into 1994. When the World Bank pulled out of its commitment to the project, it appeared as if an important milestone in the history of the project has been crossed. The Gujarat government exhibited its determination to go full steam ahead with the project, despite the adverse comments made by Mr.Bradford Morse which played a role in the cancellation of the World Bank loan. It decided to go to the public to raise funds through the Narmada bonds and emerged triumphant when the bonds issue was oversubscribed twice over.

NARMADA BACHAO ANDOLAN

The most vociferous amongst the "anti-dam" groups has been the Narmada Bachao Andolan which has put all its efforts to oppose the project. What began as a campaign for better rehabilitation for over one lakh oustees of this project, spread across the three states, has crystallized into a movement against large dams. While the actions of the NBA have revolved round the government's efforts to move and relocate people living in the submergence area, particularly in Maharashtra and M.P., its ideological position has been centred on questioning the direction of a development policy which does not weigh the benefits and the costs of projects like the Narmada for the people living in their shadow.

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While the project seemed to move from strength to strength in building the dam, the NBA touched the lowest point in its credibility in the course of its eight-year struggle against the dam in 1993. Then the indomitable Ms.Medha Patkar went on a fast unto-death in June 1993 in Bombay demanding that the Central Government institute a review of the project. Once again, in another act of desperation the NBA announced that they would do "Jal Samarpan" and it was set up for August 6th, 1993. At the very last minute, the Government announced the formation of a review committee. To push through their point of view, NBA activist's have lobbied in India and abroad. They have petitioned the World Bank, and resorted to some, rather dramatic actions, such as the decision to wait until the flood waters drowned them in the village of Manibeli in Maharashtra, to demonstrate their opposition to the project.

The movement and protest is still going on.

19.7. GREEN PEACE MOVEMENT

A new movement in Germany, the Greens, in their call for a new world order, are challenging the basic assumptions of both the left and the right. The Greens have introduced a program based on ecological wisdom, social responsibility, grass roots democracy, sexual equality, and non violence at all levels. Green politics call for a sound, sustainable economic system that is decentralized, equitable, and comprised of flexible institutions, one in which people have significant control over their lives. They propose an integrated approach to the current ecological, economic, and political crisis, which according to them are interrelated and global in nature. They speak of the "spiritual

impoverishment" of industrialized societies. They have asked questions that neither of the major parties nor the government could answer.

19.7.1. Who are Greens?

Greens consider themselves as a political voice of various citizens movements, that is, ecology, anti-nuclear power, peace, feminist, and others. Most members of the Green party are also activists in one or more of these movements, and this diverse orientation is reflected in the wings, or factions of the party: the visionary/holistic Greens, the Eco Greens, the Peace-movement Greens, and the radical-left Greens.

The holistic Greens call for more sensible, post-patriarchal ways of interacting with nature, individuals, groups, and other countries. They are concerned with inner development as well as comprehensive politics.

The Eco Greens focus their efforts primarily on protecting the natural world from toxic wastes, radiation, air pollution, and other hazards, as well as promoting "eco development", that is, the use of renewable-resource technologies for energy and industry.

The Peace Movement Greens concentrate primarily on garnering public support for the Green party's peace program. The radical left Greens, are those who entered the Green party from various communist groups.

In calling for an ecological, non-violent, non-exploitative society, the Greens transcended the linear span of left-to-right. By March, 1983, Green Party was represented by 27 parliamentarians in West Germany's national assembly.

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19.7.2. Principles of New Politics

The Greens began their national program by explaining why new politics is necessary :

"The worldwide ecological crisis worsens from day to day: natural resources become more scarce; chemical waste dumps are subjects of scandal after scandal; whole species of animals are exterminated; entire varieties of plants become extinct; rivers and oceans change slowly into sewers; and humans verge on spiritual and intellectual decay in the midst of a mature, industrial, consumer society. It is a dismal inheritance we are imposing on future generations....."

Policies of Green politics were guided by long-term visions for the future and are founded on four basic principles : ecology, social responsibility, grass roots democracy, and nonviolence.

All of them can be understood within the context of 'deep ecology', a concept that encompasses the study of natures subtle web of interrelated processes and the application of that study to our interactions with nature and among ourselves. Inter-relatedness and ongoing processes are the lessons the Greens take from and apply to the ecosystems surrounding us. The second of the four pillars, 'social responsibility' , is understood by most Greens to mean social justice and an assurance that the poor and the working class will not get hurt by programs to restructure the economy and our consumer society ecologically. The third principle 'grassroots democracy', means an increased realization of decentralized, direct democracy. The decisions taken at the grassroot level were given priority. The fourth pillar 'nonviolence' the cessation of both personal violence and structural violence. Greens advocated peace education in the schools and showed children that the cult of

the soldier is a cultural, not natural condition. The Greens extend their principle of nonviolence to their active resistance against the most massive and potentially deadly manifestation of structural violence.

19.7.3. Politics of Peace

Educating the public comprises a large portion of the Greens peace work. They try to get people to recognize the connection between militarism and ecological damage. Most obvious is that military maneuvers directly endanger the environment. The connection between a lasting peace and a radical restructuring of the economy and societal habitats is also stressed.

Green activists conducted a number of public actions designed to educate people about the dangers of the new missiles and to establish stronger contacts with the peace movement in other countries. The first educational event, the "Tribunal against First Strike and Mass-Destruction Weapons in the East and West", was a conference held in Nuremberg. The Greens participated in a peace conference in West Berlin. After an all-night Planning session, six of them crossed the border dividing that city and staged a peace demonstration in Alexanderplatz, a large square in East Berlin. The Greens urged the American activists to conduct demonstrations in solidarity with the German ones or even to come to West Germany and participate directly. They also held demonstrations in front of the White House and issued a peace declaration jointly with peace groups of America.

19.7.4. Bringing Grassroot Ideals into Electoral Politics

The development of a party program, which can be used for electoral campaign, involves extensive consultation with the grassroots membership. The Green Party in the state of Hesse, for instance, selected a program committee who invited suggestions from all members on the issues of peace, employment and the economy, energy, the environment, city planning, living places, traffic management, democratic rights, culture and education, women, children and young people; discrimination against minority groups and health. With the grassroots campaign, run on a shoestring budget, the Greens raised a common voice against industrialization (particularly the EEC's heavy investments in nuclear power) and for an ecological and regionalised Europe.

The Greens campaign was conducted mostly at the district level, coordinated by a small state wide office. Their strategy consisted of 3 parts: distributing their printed material, working with citizens movements, and producing a few brief ads for television. They published a short version of the program in pamphlet form with the holistic title, "Thinking Within Contexts: Acting for a Future Worth Living In". In addition, the Greens printed a colorful poster showing the Hesse lion, their state symbol, having stepped down from his ferocious, medieval pose and become a rounded, smiling cat lounging contentedly on the grass before green, rolling hills. The slogan was "Let Hesse become Green". The Greens introduced numerous issues not discussed before in Bundestag (German Parliament), such as opposition to the census, opposition to nerve gas and deployment, numerous ecological concerns, and women's rights, and presented a much higher proportion of questions to the government than the other parties.

19.7.5. Worldwide Green Movement

A close look at the current political and economic scene reveals that the Green critique applies not only at local and national levels but globally as well. In fact, most of the major problems of today are global in nature. Whether it is international politics, the armaments debate, food policy,

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international finance, or communications, everything is related to a finite, densely populated, globally interdependent world. Recognizing the dynamics of the global community and its embeddedness in the global ecosystem is essential, there is stress for global Green politics. In other words, the application of the Green perspectives to the whole earth and the entire human family is increasingly being felt as necessary. Because of the tight inter-connectedness at multiple levels, a global approach to economics and politics is recommended as urgently needed.

The Greens have clearly recognized the disastrous effects of transnational corporate exploitation, and hence they always insist on solidarity with the Third World. Global Green politics involve a thorough redefinition of the concept of development. The Green principle of grassroots democracy implies. furthermore, that a group in one country should not design development strategies for other countries. Instead, Third World people may be helped to design their own paths of development, starting from their own cultural roots and from taking pride in their cultural heritage.

Another aspect of Green politics is reconceptualization of strategies of war and peace by shifting from the current high-tech approach to more human-based systems for defense and conflict resolution. as well as adopting the concept of social defense. Green politics recognizes that in the nuclear age the entire concept of national scrutiny has become outdated, that there can be only global scrutiny. This recognition found impressive support in the report of the Palme Commission, Common Security. It is exactly this position of the international peace movement that is likely to become one of the strongest expressions of global Green Politics. The emergence of Green politics, is guided by a fairly uniform set of principles, is a global phenomenon that will become increasingly visible. In accordance with its principle of decentralization and grassroots democracy , the global Green movement is growing from below, manifesting itself locally in the form of Green alliances and coalitions, and subsequently in the formation of National Green parties. At the same time a set of global citizen-based networks is gradually emerging, which distributes information about ecological and human rights issues around the world.

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19.8. AN EVALUATION

Some Germans believe that the Greens are a necessary voice in government as ecological guardians of the future. Other citizens feel the Greens are probably right about some issues but are too radical in general. Still others blame the Greens as disrupters of the status quo, lacking an understanding of political and economic necessities. Finally, much of the radical left finds the greens not radical and disruptive enough, criticizing their "bourgeois" goals and tactics in leftist publications.

Since winning seats in most of the legislative bodies in West Germany, the Greens have become the political voice of the citizen's movements in the forums of power and a conduit for privileged information from those forums to the movements. They also have fundamentally effected the political debate.

While the emergence of Greens has upset the conventional parties and political leaders, they also have inspired many other groups. They have empowered the citizens movements in numerous ways, and the rippling effects of their electoral victories have inspired the growth of the new politics throughout the global Green network. They have brought into politics more than a grassroots, non-authoritarian style and future-oriented approach; they have incorporated what the German philosopher Ernst Bloch called the principle of hope.

The Greens have problems because they have fears, insecurities, ambitions, desires, grudges, regrets. rivalries, mistrust, self-doubt, and defense mechanisms. They also have deep friendships, courage

perseverance, and genuine idealism. That is to say, they are complex, intelligent human beings who are struggling to create a new milieu that supersedes their past conditioning, both personal and political. They are succeeding in some areas, failing in others. They are finding their way.

A research group, Trend-Radar, determined the characteristics of the Greens to be the following :

* They facilitate the dissolution of men's-club politics; they support female, and hence holistic thinking.

* They try out process politics; there is permanent learning.

* They test flexible forms of organization, which causes delicate problems with communication and voting.

* They redefine power; holding office is not seen as a sign of superiority but as "holy sacrifice"

* Emotions, intuition, and a new balance between play and seriousness have entered politics.

* They are talented media professionals and have a good communicative network.

* Collective self-organization is an important source of the Green movement.

* They have begun a transformational process that transcends left-right thinking, and that momentum for transformation is crucial to their success.

* They have reintroduced morality into politics and attempt to develop a new morality.

Petra Kelly, a leading figure in the Green Party, puts in a word of caution :

The Green party is now at a very critical point. On one hand, it has achieved everything it hoped for in the last few years. On the other hand, it could lose it all very quickly within the next two years by literally trying to find ways to make a little influence here, a better life there, and losing sight of the larger goals. As for our work in the Bundestag, if we would just successfully address four basic points - ecology, nuclear power and weapons, health, and the exploitation of the women- the entire existence of the party would be justified. Getting people to reject the idea of deterrence must be a major goal for us. If the Greens end up becoming merely ecological Social Democrats, then the experiment is finished- it will have been a waste.

Greens have established themselves in the eyes of many political analysts as the third-ranking party in Germany. Their membership continues to increase, and their programs continue to evolve. In 1983, the Nobel Laureate Heinrich Boll said, "The Greens are always my hope."

19.9. SUMMARY

Hundreds of field level groups today take keen interest in environmental issues and their experiences and interests are extremely diverse. While most groups attracted varying degrees of media attention, there are many, many others which are doing excellent work in mobilizing people, both to prevent further ecological destruction, often in the face of determined government policies, and to bring about ecological regeneration.

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This Chapter has presented a few case studies. The student can read these with the case studies presented in the Chapter on Industrial Pollution. Based on these studies, it can be concluded that most movements in India have been issue based. For this reason, a case study of the Green Party Movement was presented here to give an overall picture of direction, in the politics of environment. Even India is moving in such a direction, towards such a Green party, but has still a long way to go, since it has to resolve the conflicts of environment and development. In India, in 1995, there was an attempt to move in such a direction: A National Alliance for People's Movements was formed, with the active participation of Ms.Medha Patkar of Narmada Bachao Andolan. However, movements in India have to consider and work within the constraints and limits imposed by our social, cultural and economic systems.

19.10. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The Silent Valley Project was proposed to be built on the Kundhipuzha river in the Palghat district of Kerala.

2. The committee constituted by Kerala Shastra Sahitya Parishad, NGO, suggested that if the dam is built, large tracts of forest area is inundated and is to be handed over to the electricity department. Thus forest devastation would begin. The submergence would also have deleterious effects like destruction of shore line, riverine, vegetation and the disapparance of several valuable species of flora and fauna.

19.11. MODEL EXAMINATION QUESTIONS

I Answer the following questions in about 30 lines each.

1. Write an account on Silent Valley Movement.
2. Briefly write about Chipko Movement.
3. Write briefly about Narmada Controversy.
4. What is Green Peace Movement? Briefly explain about it.

II. Answer the following questions in about 10 lines each.

1. Write briefly about Narmada Bachao Andolan.
2. Who are Greens?
3. Write about politics of peace.
4. Write about world wide green movement.

A. Shashikala
D. Narasimha Reddy

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UNIT-20 : JUDICIAL/LEGAL RESPONSE

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20.1. OBJECTIVES

After going through this unit, you will be able to :

* define environmental law,
* discuss about individual, law and protection of environment,
* describe the environmental protection measures in India,
* describe the role of courts in the protection of environment,
* describe the Public Liability Insurance Act.

20.2. INTRODUCTION

In India, its long history of culture and traditional belief ensured that Nature and its laws cannot be ignored by the humanity to prolong its existence. Indian cultural ethos was reflected in the Constitution, in 1950, long before any governing system in the world recognized the problem of environment. The directive Principles of State Policy, in Part IV of the constitution, extensively deals with the improvement in the quality of life. Article 39 of the State Policy says: " the State shall, in particular, direct its policy towards securing -

b) that the ownership and control of material resources of the community are so distributed as best to subserve the common good,

c) that the operation of the economic system does not result in the concentration of wealth and means of production to the common detriment"

This is better understood in the current debate on environment as the urge for a better quality of life in conjunction with ecological balance. Here the reference to material resources includes natural resources like air, water, and land. further Article 48A says, "the State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country". And in Part III of the Constitution, Article 21 confers the fundamental right to life, in these words : "No person shall be deprived of his life or personal liberty except according to procedure established by law".

Apart from Constitutional provisions, there have been several Central enactments which deal with different aspects of social resources, public health and natural resources piece meal like : Mines and minerals (Regulation and Development) Act, 1947, Industries (Development and Regulation) Act, 1952. Food Adulteration Act, 1954, River Boards Act, 1956, etc.. Most of these Acts recognize the destructive effect of the respective human action on nature and species, and proceeded to put limitations on such an activity. The main purpose of these Acts was regulation of Development.

Protection of environment has assumed even more importance in recent times with industrialization resulting not only in over exploitation of natural resources but also pollution of air, water, flora and fauna. While development is essential to every economy, it is also essential that no irreparable damage is caused to the eco-systems. Hence, the approach would necessarily be that of sustainable development to balance the exigencies of individual growth against the trade-offs concerning preservation, protection and promotion of ecology and environment.

Internationally, the cause of environment was first highlighted in the U.N. Conference on Human Environment held at Stockholm in June, 1972. Since then various countries such as Japan, U.S.A., France, Germany, etc.. besides India have enacted legislative measures for protection of the environment by introducing strict penal measures for damage caused due to hazardous substances. In India, the Water (Prevention and Control of Pollution) Act was enacted in 1974 and Air (Prevention and Control of Pollution) Act was passed by Union of India in 1981, essentially to give affect to the decisions taken at the Stockholm Conference. Since 1972, various international conferences were organized on the subject of environment and ecological protection and conservation planning. The most recent one being the U.N. Conference on Environment and Development more popularly known as the Earth Summit, at Rio de Janeiro in Brazil, June, 1992. This meeting was based on a Report, Our Common Future, prepared by the Brundtland Commission for the United Nations, which developed upon the theme of sustainable development. Earth Summit was held to focus the attention of the world on the problems of environment and to look for ways in which these can be avoided in future.

20.3. ENVIRONMENTAL LAW

The subject of environmental law cuts across so many fields and disciplines that ultimately no two experts, not only in law but in other fields, are ever likely to agree at any one time. For all practical purposes, environmental law is treated as laws and rules of law which exist to prevent or reduce harm to the natural environment.

From Section 2(a) of the Environment Protection Act, 1986, comes a legal definition of the environment as inclusive of the air, water and land and the inter-relationship which exists among them, and human beings, other living creatures, plants, micro-organism, and property.

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Under Section 2(c), pollution of the environment is defined as the release (into any environmental medium) from any process, of substances which are capable of causing harm to man or any other living organisms supported by the environment.

20.4. INDIVIDUAL, LAW AND PROTECTION OF ENVIRONMENT

In the face of global environmental problems, it is all too easy to feel powerless. Even in their own neighborhoods, many people feel that there is little they can do to stop the relentless pace of environmental destruction or force the authorities into taking action to prevent pollution. "Think Globally and Act Locally" has long been a slogan of environmental and green movements, but how can the individual citizen take initiative to stop environmental harm? One option is through law. An oft quoted phrase, used in many context, is 'there ought to be a law against it'. When it comes to harming the environment, there is a frequent need for law.

Far from being powerless, every citizen may invoke a wide range of laws, provided they have access to the right information and a knowledge of the practical steps involved. The notion that ordinary citizens should use the higher levels of judiciary was made possible (by the Supreme Court by introducing the concept of Public Interest Litigation (PIL)) or the public spirited citizens it enables to espouse the cause of others or a matter of public importance through a process of judicial legislation.

Existing constitutional and legal rights, originally devised to cover non-environmental matters, may nonethless be utilized by the individual citizen to protect the environment. These include a system of private rights (Civil Law) by which an individual can protect his or her person or property,and various parts of criminal law covering anti-social activities normally controlled and punished by the state, but which may also be utilized by private citizens.

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20.5. ENVIRONMENTAL PROTECTION MEASURES IN INDIA

It has to be mentioned here that IPC 1860 contains penal provisions for corrupting or fouling the water or spring or reservoir so as to make it noxious to the health of any person etc.. Also a number of central and state laws covering boilers, dangerous drugs, forests, etc.. were enacted during the middle of the 20th century. But, legislative and administrative measures directed specially at protection of the environment were introduced only in 1970's and 1980's.

In 1977, by an amendment to the Constitution, Art 48-A was included in the Directive Principles of State Policy, imposing a duty on the state to protect and improve the environment and safeguard the forests and wildlife of the country. The newly introduced 51-A (under Fundamental Duties) also inter-alia provided for the protection and improvement of the natural environment including forests, lakes, rivers and wildlife and to have compassion for the living creatures. Consequently, the Water (Prevention and Control of Pollution) Act and the Air (Prevention and Control of Pollution) Act were passed in the year 1974 and 1981 respectively.

The issues of the pollution control and environmental protection assumed enormous importance after the Bhopal gas tragedy in December, 1984; in which several people lost lives or became permanently handicapped following the M.I.C.gas leak in the Union carbide plant at Bhopal.

In 1986, the government enacted the Environment Protection Act to provide for the protection and improvement of the environment and prevention of hazards to human beings, other living creatures, plants and property.

The Law on environment currently exists to :

* Set standards and safe guards which individual persons, corporations, and governments have to observe and adhere to regarding emissions and release of substances into the environment.

* Give rights to challenge and review decisions taken by the public institutions/bodies including national, State and local governments (ex: planning decisions).

* Fix criminal sanctions and penalties for those who damage or pollute the environment. These measures seek to curb and control activities which harm human, animal and plant life and the soil, water resources and atmosphere in their capacity to support life.

* Provide private rights to citizens to tackle on an individual basis environmental pollution which harms his or her personal welfare and the enjoyment or exploitation of rights.

20.5.1. Atmosphere

There are two distinct ways by which the law controls air pollution. These can be classified as :

* The Air (Prevention and Control of Pollution) Act and

* Certain statutory bodies set up under the Air (Prevention and Control of Pollution) Act with the task of controlling pollution and protecting the environment.

Until the enactment of Air (Prevention and Control of Pollution) Act, there was no concerted effort to legally control air pollution. State municipal acts have not been effective to enable sufficient control over air pollution. With a view to meeting the problem in more concrete terms, the central government initiated legislation to prevent air pollution exclusively. Various amendments were made to this Act through the Air (Prevention and Control of Pollution) Amendment Act, 1987.

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20.5.2. Provisions under Act

Certain statutory bodies have been set up to control pollution and protect and conserve the environment. These are the Central and State Pollution Control Boards. They have the daily task of policing pollution and putting environmental legislation into effect.

Provides that no person shall, without the previous consent of the State Board establish or operate any industrial plant in any area.

Imposes an obligation on the person in charge of the premises wherever emission of any air pollutant occurs or is apprehended, to furnish the fact of any occurrence or apprehension of emission of any air pollutant into the atmosphere in excess to the standards laid down by the State Board.

For the purpose of carrying out the functions entrusted to it, the local bodies including the State Boards or any officer empowered by it have responsibility for the following :

* for any information regarding the types of air pollutants emitted into the atmosphere and the level of the emission of such air pollutants, to be collected from the occupier or any other person carrying on any industry or operating any control equipment or industrial plant.

* for the purposes of verifying the correctness of such information, the State Board or such officer shall have the right to inspect the premises where such industry, control equipment or industrial plant is being carried on or operated. After the 1987 amendment, such right extends to obtaining information from industries operating even outside the air pollution control areas.

* has the power to take samples for the purpose of analysis.

* establishes a positive right for any person seeking environmental information to obtain it, subject to certain exceptions. It should be noted that there are no limits placed upon the purposes for which the information is supplied. As a result information may be used openly for political purposes by political parties, lobbying groups and campaigning organizations in order to achieve appropriate changes in the laws.

This Act empowers the State Boards to give directions in writing to any person, officer or authority who shall be bound to comply with such directions. This includes the power to direct :

* closure, prohibition or regulation of any industry, operation or process.

* stoppage or regulation of supply of essential services to such industry.

Under the Act, necessary authorities can prescribe penalties for failure to comply with the provisions of the Act.

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At present, the control of air pollution is largely administered by the State Boards. Many emissions in the air fall under the pollution control process allocated to local control under Air (Prevention and Control of Pollution) Act. However, it is possible to find indications in the law that these powers may be replaced by increasing control exercised by the Central Government. With the control regime being in the hands of elected authorities, there is a limit to the efforts of an individual citizen to curb atmospheric pollution. Major difficulties also exist for collecting evidence with many emissions being invisible. To uncover a number of offenses under the Air (Prevention and Control of Pollution) Act requires both a relevant knowledge of engineering and a power of entry to obtain access to the premises concerned. Nonetheless, much could be done to encourage existing bodies to exercise their statutory powers and influence policy.

20.5.3. Water (Prevention and Control of Pollution) Act, 1974

Despite attempts having been made for over half a century to control the discharges into the rivers, water pollution remains a major problem. Findings reveal that industry is not the only offender, even modern farming methods generate large amounts of water pollution from fertilizers apart from urban sewers.

The Water (Prevention and Control of Pollution) Act, 1974, was enacted to provide for the prevention and control of water pollution and maintaining and restoring wholesomeness of water, for the establishment of Boards, with a view to carrying out these purposes, for conferring on and assigning to such Boards powers and functions relating thereto. Under Section 2(e) of the water (Prevention and Control of Pollution) Act, a person commits an offense if he causes or knowingly permits any poisonous, noxious or polluting matter or any solid waste matter to enter any controlled waters.

20.5.4. Provisions under Act

This Act empowers the central government to constitute a Central Pollution Control Board and State government to constitute a State Board.

The powers of the Central Board include :

* advising the central government on any matters concerning the prevention and control of water pollution.

* co-ordinating the activities of the State Boards and resolving disputes amongst them.

* planning and organizing the training of persons engaged or to be engaged in programmes for prevention, control or abatement of water pollution.

* organizing through mass-media a comprehensive programme regarding the prevention and control of water of pollution.

* collecting, compiling and publishing of technical and statistical data relating to water pollution and the measures devised for its effective prevention and control.

The Act provides generally that the Central Board shall have the main function of promoting cleanliness of streams and wells in different areas of the country. Further, the Central government may direct the Central Board to perform the functions of a State Board which had defaulted in complying with any directions given by the Central government.

The Board may establish or recognize a laboratory or laboratories to enable the Board to perform its functions efficiently, including the analysis of samples of water from any stream or well or of samples of sewage or trade effluents.

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20.5.5. Functions of State Board

* To collect and disseminate information relating to water pollution and the prevention, control and abatement thereof.

* To encourage conduct and participate in investigation and research into the problems of water pollution and prevention, control or abatement of water pollution.

* To lay down, modify or annul effluent standards for the sewage and trade effluents and for the quality of receiving waters resulting from the discharge of effluents and to classify water of the State.

* To evolve methods of utilization of sewage and suitable trade effluents in agriculture.

This Act prohibits the use of stream or well for the disposal of polluting matter. It imposes restriction on new outlets and discharges, making it obligatory on the part of a person to obtain the consent of the Board for establishing or taking any steps to establish any industry, operation, or process which is likely to cause pollution of water.

Concerning emergency measures in case of pollution of streams or well, accordingly wherever it appears to the State Board that any poisonous, noxious or polluting matter is present in any stream or well by reason of the discharge of such matter and the Board is of the opinion that it is necessary or expedient to take immediate action, it may carry out such operations as it may consider necessary.

These Boards have power to apply to the Courts for restraining apprehended pollution of water in streams and wells and for restraining persons likely to cause such pollution from so causing.

With Section 33A, introduced through a 1988 ammendment, boards have been empowered to give directions including closure of an offending industry - a very important provision indeed. This Act also prescribes various penalties for failure to comply with the directions of the Boards and orders issued under the Act.

It also provides penal liability for offenses by companies. Every person who at the time of commission of the offense was committed was in charge of or responsible for the conduct of the business of the company, shall be deemed to be guilty of the offense and shall be liable it be proceeded against and punished accordingly.

No court shall take cognizance of any offense under the Act except on a complaint made by :

a) Board or any officer authorized by it.

b) any person who has given notice of not less than 60 days of the alleged offense of his/her intention to make a complaint to the Board or authorized officer.

It is worth noting that in order to elicit public cooperation, this section was amended in 1988. Accordingly, any person can complain to the courts regarding violation of the provisions after giving notice as stated above. Where any person makes a complaint as above, he/she is entitled to be furnished with the relevant reports by the Board on demand.

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The Act empowers the levy and collection of a Cess on water consumed by persons carrying on certain industries and by local authorities. The object of the cess act is to see that the State or Central Boards are able to raise sufficient funds other than that are being contributed by the State and Central governments, in the effective discharge of functions contemplated under the pollution control act.

20.5.6. Environment (Prevention and Control of Pollution) Act, 1986

Although various legislations deal with several environmental matters, their focus was either on specific type of pollution or on specific categories of hazardous substances. Some major environment hazards were not covered by these enactments. Therefore the need was felt for a general legislation for environment protection which would enable co-ordination of activities of the various regulatory agencies and creation of an authority with adequate powers for environmental protection. Apart from this, there was a dire need to cover discharge of environmental pollutants and handling of hazardous substances, while providing for a speedy response in the event of accidents threatening environment and deterrent punishment to those who endanger human environment, safety and health.

The Central government has been granted general powers (Section 3) under the Act to take all such measures for protecting and improving the quality of the environment and for preventing,

controlling and abating environmental pollution which may include :

* planning and execution of a nation-wide programme for the prevention, control and abatement of environmental pollution.

* laying down procedures and safeguards for the prevention of accidents which may cause environmental pollution and remedial measures for such accidents.

These procedures and safeguards enable the prevention of discharge or emission of any environmental pollutant in excess of such standards into air, atmosphere or land, as may be prescribed.

The rules provide that the standards for emissions or discharge of environmental pollutants shall be as specified in Schedule I to the rules. These standards are to be complied within a period of one year of being specified unless the Central or State Board has specified any other period in respect of any industry, operation or process. The rules provide for submission of an environmental audit report by every person carrying on any industry to the concerned State Pollution Control Board.

Under the Eco-mark Scheme, government decided to issue eco-mark labels to 15 industrial products (soaps and detergents to begin with) which cause minimum or no pollution and will be deemed as environmental friendly. The general requirements to be met by these products are that they should confirm to the standards of the Bureau of Indian Standards and the manufacturers must produce the consent and clearance under the Water, Air, and Environment Protection Acts.

The National Environment Tribunal Bill, 1992, was introduced in the Lok Sabha to give effect to the decision taken at the Earth Summit in 1992. The Bill provides for strict liability for damages arising out of any accident occurring while handling any hazardous substance and for the establishment of a National Environment Tribunal for effective and expeditious disposal of cases arising from such accidents, with a view to give relief and compensation for damages to persons, property and the environment for matters therewith or incidental thereto.

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Check Your Progress - 1

What for the Water Act, 1974 was enacted?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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20.6. ENVIRONMENTAL LAWS AND COURTS

Courts have important role in the protection of environment. Unfortunately, legal means have often been found inadequate especially in the last decade. However, there have been quite a few land mark judgments which have widened the scope of judicial intervention in the overall interests of

humanity to protect the environment and ensure development. Ironically, none of the specific laws on environment have been invoked by the Courts in most of the path breaking judgments. Courts essentially depended on the Constitutional provisions like Article 21 and Directive Principles and the Criminal Procedure Code and Indian Penal Code.

However, the courts are burdened with plethora of cases. Estimates show that 4,500 pollution related cases and more are pending in various courts in India. And because of this and other factors, public interest litigation has in no way been an unqualified success. Secondly, the judicial system in general suffers from inadequate understanding of the different dimensions involved in cases dealing with environment. thirdly, many of the cases in India involve the basic rights and survival of communities and a seemingly endless factors of influence and importance. Fourthly, political and administrative processes are discontinuous in their response to judicial interventions and often are captive of anti-environmental interests.

However, importantly, the courts have been working on the liability of environmental destruction. None of the environmental protection laws contain any provision for compensation to those affected by environmental degradation. The offenses in the case of pollution are punishable crimes but do not cost civil liability in case of damages or losses caused to the environment, people and their life, health and property.

20.7. LIABILITY FOR POLLUTION - RECENT TRENDS

Liability for pollution, whether the pollution is caused by individual or by a corporation, may be civil or criminal, will have to be fixed.

* Civil liability, refers to what is known as tortuous liability. A tort is a civil wrong for which the ordinary remedy is damages. The duty breached by the wrongdoer is not one owed to any particular person but one owed to all persons in general who are likely to be affected by the particular wrongful conduct. Of the various species of torts, negligence is the most directly related tort in the field of pollution. Some times the tort applicable may be that of public nuisance.

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Where liability is sought to be assigned against a person for an unintentional wrong on the basis of negligence, it must be proved that the defendant owed a duty of care towards the plaintiff.

The 1866 ruling in RYLANDS vs FLETCHER provides that the person who for his/her own purpose brings onto his land and collects and keeps there anything likely to do mischief, if it escapes, must keep so at his own peril and if he fails to do so is prima facie liable for the damage.

* The liability under this rule is strict and it is no defense that the thing escaped without that persons willful act, default or neglect or that he had no knowledge of its existence.

* This rule laid down the principle of liability that if a person brings on his land and collects and keeps there anything likely to do harm and such thing escaped causing damage to another he is liable to compensate for the damages caused.

* However, this rule applied only to non-natural uses of land, and not to things which occur naturally on the land or where the escape is due to the act of god or an act of a stranger or the default which escaped is present by the consent of the person injured or where there is statutory authority for doing such act.

Generally, a person is liable only for a tort committed by himself or assisted or encouraged by him or for a tort in which he has participated. However, if an employee commits a tort within the scope of his employment, the employer also becomes liable.

This **vicarious liability** can be attributed against a corporation also for a tort committed by its employee within the scope of its employment. If the corporation has been guilty of tortuous conduct, say for example, negligence in the management of a factory causing harmful pollution, can the director or the other officials be made liable to pay the damages for the tort? Although such extension of liability against the director etc was not known till recently, the Supreme Courts decision in ShriRam Fertilizers case is a trend setter in this direction.

In this case, the Supreme Court was considering a writ petition seeking recommencement of manufacturing operations in the plant, after it was ordered to be closed down because of a major leakage of oleum gas. The Court allowed the recommencement of manufacturing operations subject to the condition that the Chairman and Managing Director of the company as also the officers who were in actual management of the plant concerned gave an undertaking that in case there was any escape of the gas resulting in death or injury to the people living in the vicinity as well as to any workman, they shall be personally liable for payment of compensation for such death or injury.

The Court however clarified that if the escape of gas took place as a result of sabotage or where the officer proves that he had exercised all due diligence to prevent the escape of the gas, he shall be entitled to be indemnified by the company.

The pollution laws, at present, are so stringent that non-confirming factories may be asked to even close down. The laws further provide that where a State Pollution Control Board does not act in a particular case, the Central Pollution Control Board shall take suitable action in the matter. Further, any person directly in charge of and responsible for conducting the affairs of the company shall be deemed to be guilty and shall be liable to be proceeded against and punished for an environmental offense, thus marking a significant departure from the traditional principle of **mens rea** (or a guilty mind) and shifting the onus of no-guilt on the person concerned.

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The Supreme Courts' subsequent ruling in M.C.MEHTA and ANOTHER verses UNION OF INDIA and OTHERS marked the emergence of a new trend in jurisprudential firmament. The Court in this case ruled that an application for compensation in a pollution case can be maintained under Article 32 (Right to Constitutional remedies- the variety of rights coming up for enforcement being the fundamental rights given by the Constitution). According to the Court, this is right because such application is for the protection of the people and the Court has all incidental and ancillary powers including the powers to forge new remedies and fashion new strategies designed to enforce fundamental rights.

The Court was almost close to concluding that a private corporation (meaning a public limited company) would fall within the scope and ambit of Article 21 of the Constitution.

On the question of liability of an enterprise engaged in hazardous activities, the Supreme Court laid down for the first time a far reaching ruling which is, that an enterprise which is engaged in hazardous or inherently dangerous activity and an industry which poses a potential threat to the health and safety of the persons working in the factory and residing in the surrounding area owes an absolute and non-delegatable duty to the community to ensure that no harm results to any one on account of an hazardous or inherently dangerous nature of the activity which it has undertaken.

The Court also ruled that the measure of compensation must be correlated to the magnitude and capacity of the enterprise because such compensation must have a deterrent effect. It further reiterated that the rule in Rylands vs Fletcher of strict liability would apply in India but without any exceptions recognized in England.

In recent times, criminal liability of corporations in the sphere of pollution has also been going up. One such important case is a ruling of the Supreme Court in the U.P. Pollution Control Board vs. Modi Distillery. In this case, the company did not have proper arrangement for treatment of the highly polluted trade effluents discharged by it and although the Appellant Board repeatedly required the company to obtain the consent of the Board, the company was intentionally and deliberately avoiding compliance of the requirements. In an application under Cr.P.C for quashing the proceedings, a single judge of the High Court held that no vicarious liability could not be saddled on the Chairman, Vice Chairman and M.D and other members of the board unless there was prosecution of the parent company, i.e., Modi industries.

The Supreme Court held that although as a pure proposition of law in the abstract, the view of the High Court that there could be no vicarious liability of the Chairman and others unless there was prosecution against Modi Industries Limited (the company owning the industrial unit) can be termed correct. But it holds good as long as the matter is dealt with in isolation, without cognizance of the facts and events of the case. Ultimately, the Chairman, Vice Chairman, Managing Director and the Board of Directors, who were in charge of and responsible for the conduct of the business of the company, were deemed to be guilty of the offense and liable to be proceeded against and punished.

20.8. PUBLIC LIABILITY INSURANCE ACT, 1991

This is the first of its nature in the world enacted for the purpose of providing immediate relief to persons affected by accidents, covering the public in the vicinity who may be victims but not assured of relief except through long drawn legal process.

Considering that majority of the affected are people belonging to weaker sections of the society who have very limited resources available to go through legal proceedings, this Act provides for mandatory public liability insurance for installations handling any hazardous substance notified under the Environment Protection Act.

Application for relief is to be made by the applicant to the District Collector within 5 years of the accident who shall make the award determining the amount of relief payable.

Check Your Progress - 2

What is the purpose of Public Liability Insurance Act,1991.

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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20.9. CONCLUSION

Had the law alone been effective in restraining pollution, much environmental damage could have been prevented years ago. Environmental law cannot alone make people respect or revere environment and the natural world. There are limits to law. But it can do something to prevent the harm currently occurring, set standards and punish those who fail to observe those standards.

One problem is the pace of technological change. Technology and the development of new products and processes have leaped ahead of piecemeal development of environmental legislation. Some times environmental harm or damage is only discovered many years after it has been caused, too late for any legal measure to be of any use. In some cases, even where harm is recognized, society does not take effective steps to control it such as automobile pollution. Political factors also affect the development of environmental law. Selective lobbying by commercial and industrial sectors may even prevent environmental law from coming into force.

As yet, many of the rights enlisted in the laws and much of the legislation described largely remains untested. These rights, however, are there to be used, despite the drawbacks outlined. The choice now available is whether environmental law remains the exclusive preserve of the State bodies and serves limited interest groups or becomes a tool for achieving effective environmental protection in the interest of all. Far from being powerless, the individual citizen, if armed with determination and a certain knowledge of environmental law, is now in a position to undertake public action with a greater chance of success than ever before.

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20.10. SUMMARY

In India, its long history of culture and traditional belief ensured that nature and its laws cannot be ignored by the humanity to prolong its existence. Apart from constitutional provisions, there have been several central enactments for the protection of environment. Internationally, the cause of environment was first highlighted in the UN Conference on Human Environment held at Stockholm in June, 1972. The subject of environmental Law cuts across so many fields and disciplines that ultimately no two experts are ever likely to agree at any one time.

The Indian penal code 1860 contains penal provisions for corrupting or fouling the water or spring or reservoit so as to make it noxions to the health of any person. In 1977, by an amendment to the consittution, Art 48-A was included in the Directive principles of State policy imposing a duty on the state to protect and improve the environment and safeguard the forests and wild life of the country.

Courts have important role in the protection of environment. Unfortunately legal means have often been found inadequate especially in the last decade. Estimates show that 4500 pollution related cases are pending in various courts in India. Unfortunately none of the environmental protection laws contain any provision for compensation to those affected by environmental degradation.

20.11. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The Water Act, 1974 was enacted to prevent and control water pollution, for the establishment of Boards, for conferring on and assigning such boards powers and functions relating to them.

2. The Public Liability Insurance Act, 1991 was enacted for the purpose of providing immediate relief to persons affected by accidents covering public in the vicinity who may be victims but not assured of relief except through long drawn legal process.

20.12. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. What are the environmental protection measures taken in India?
2. What are the provisions under the Air Act?
3. Write briefly about the Water Act, 1974.
4. Write briefly about Environment Act, 1986.

II. Answer the following questions in abut 10 lines each.

1. How can you protect your environment with the help of law?
2. What are the functions of State Board?
3. Write briefly about environmental laws and courts.
4. Write briefly about Public Liability Insurance Act, 1991.

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K. Prabhakar Reddy

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BLOCK - 6
FUTURE

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UNIT-21: ROLE OF IMPACT ASSESSMENT STUDIES

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21.1. OBJECTIVES

After going through this unit, you will be able to :

* explain the role of impact assessment in decision,
* describe the impact assessment in the cases of Hussainsagar, Kolleru lake, Tanneries in Tamilnadu, thermal environmental impact asessment & EMP of Damodar Valley.

21.2. INTRODUCTION

Impact Assessment is a tool which examines environmental problems with the goal of contributing to their solution. A environmental problem usually stems from some disturbance of the normal functioning of an ecosystem. The purpose of impact assessment has been to comprehensively bring out the true picture of the environment, and human beings interaction with nature on a day to day basis. Impact assessment has played a key role in several fields. It is a very powerful analytical tool that provides the managers of large projects to quickly assess the overall impact the project will have on the society (Gadgil,1992). Impact assessment helps the managerial staff to draw certain inferences about a proposed project, and also helps in developing future trends or projections.

Impact assessment, illustratively, is done in the following fields : (Ellenberg, 1981)

1) Day to day pollution control monitoring.

2) Pre and post constructional phases of multipurpose projects.

3) The post constructional effects of thermal and nuclear power stations.

4) The environmental hazards of a) unplanned urban expansion b) very tall multistoried buildings.

5) Consequences of laying railway lines through agricultural & urban lands.

6) Deforestation of large tracts of primeval tropical forests.

The issues mentioned above are also categorised depending upon their usefulness to the affected population, ecosystem or a habitat. Furthermore impact assessment is a tool or a basis on which good rapport with local citizens can be established. In case of a typical open cast mine, impact assessment helps to align the direction of the mine to avoid natural hazards, human habitats, ground water aquifers and tracts of tropical forests. It also illuminates the natural hazards/environmental risks/health hazards that the project will pose such as air pollution, emission of toxic gases such as methane (CH_4), carbon dioxide (CO_2), sulphur dioxide (SO_2) and hydrogen sulphide (H_2S). During the early days of industrial revolution, when analytical tools such as impact assessment studied were not available, the prediction of environmental hazards could not be undertaken. Hence many of the project workers were exposed to serious diseases. During the construction of Panama canal (1903-1915) and similarly during the expansion of the rail network in central and eastern India (1895-1935) due to lack of proper sanitation and diseases many fatalities occurred in the project sites.

21.3. ROLE OF IMPACT ASSESSMENT IN DECISION-MAKING

Executors of projects invariably seek to minimise the costs of projects and maximize the development/beneficial aspects of the society. Irrigation engineers do not plan to prevent deforestation and soil erosion in catchment areas and have little interest in the rehabilitation of those rendered homeless by dams. For them "big is beautiful" so they overestimate the inflow and necessarily increase the submergence of areas, without providing for distributaries . All this means increased cost and suffering. Therefore through impact assessment, all the alternatives and design aspects can be examined (Planning Commission, 1977) so as to maximise the total social good and not to serve some vested interests. However, impact assessment might be misutilised by vested interests, who want to bring the entire process under their control so that facts incompatible with their vested interests may be eliminated.

Presently, impact assessment has become a closed door process conducted by technical consultants who have narrow academic vision and vested interest in the form of large fees. The consultants can get manipulated so that impact assessment does not contain facts adverse to projects. In such a case, far from being impartial judges, consultants become agents of the project authorities. Their sole purpose : to legitimise project proposals (Subash, 1993). Therefore, to get a more realistic picture, impact assessment (EIS/EIA) studies should involve the public through participatory resource appraisal exercises (Roberts, 1990). There is a vast storehouse of vital information among the people on complex issues affecting their livelihood. In places like Goa, the tidal flow is regulated and villagers who have been operating these sluice gates know the characteristics of the flow on a monthly basis. Therefore it is best left to the villagers to decide how best to manage the flow if a highway, a railway track or a housing development project is obstructing it (Roberts, 1990).

Public involvement in EIS/EIA is of prime importance so that vested groups do not dominate the project. In the case of Tehri dam there is suspicion that geologists who have predicted large

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earthquakes that might occur in the future (above 8 on the Richter scale) have been silenced by pro-dam lobby. If there were a facility by which the views for and against the dam were reconciled at public hearings suspicion would not have arisen (Gadgil, 1993). Nor would there be room for suspicion prevalent today in Goa, that the very people who are decrying the prospect of a railway line passing through estuarine lands have been filling up these lands to develop real estate as a lucrative business (Subash & Gadgil, 1993). Ideally, EIS/EIA study should be an open process providing an opportunity for all interest groups to state their views. People could then decide what they want through a referendum (Glaser, 1983). Through such a referendum, Sweden decided to phase out nuclear power plants. In much the same way, Goans can decide which railway route they want or the poor farmers in coastal Tamil Nadu, Andhra pradesh, Orissa can decide whether aquaculture is beneficial to them or not (Gadgil, 1993).

Public involvement should extend to ensuring a detailed Environmental Management Plan (EMP) and ensuring that it is implemented. While planning for mega projects such as Konkan railway (1983-1992) or the underground tube railway in Calcutta (1976-1996), many minor details were excluded such as (Gadgil, 1991) :

a) Alternative sources of income to the people displaced by mega projects.

b) Alternative sources of livelihood.

c) Alternative farming systems such as eco-farming to meet the food demands of the rehabilitated people.

In case of aquaculture, due to improper EIA perspectives stagnant water seeped into the groundwater, making water unfit to drink, while land itself has been laid waste by toxic chemicals (NEERI,1995). Mangrove forests play a crucial role in fixation of nitrogen, phosphorous, oxygen, carbon, and zinc. They provide breeding grounds for coastal fishes. The flow from many rivers, canals and creeks are moving towards biological death from untreated waste. Many bird sanctuaries in Chilka lake, Kolleru lake and other estuarine habitats have been destroyed (NEERI,1995). Many aquaculture farms have violated the Coastal Zone Regulation issued by Union Ministry of Environment and Forests, in 1991. Many of them are located in the high tide level zone (HTL) 500 mts for bays and 50 mts for tidal creeks, canals and rivers. Recycling of waste water should be made compulsory (NEERI,1995). Thus because of lack of people's involvement in the pre-construction phase many vital issues pertaining to aquaculture such as viability of agricultural lands, human settlements, health and water quality have been ignored by the short-sighted project planners (NEERI, 1995).

Therefore, EIA enables analysis of available information from all sources including non-documentary sources so that checks and balances are created against vested interests. Impact assessment process will help in deciding in favour of a least impact alternative and incorporate measures to alleviate adverse impacts further. On many occasions, the EIA processes had to deviate from narrow terms of reference and look at other alternatives (Gadgil, 1993). Often, this may not be suitable to the vested interests, who usually lobby hard to modify or delete the alternatives suggested by an impartial EIA researcher (Gadgil, 1993).

In case of the Konkan railway an alternative route proposed by the EIA report was accepted in the preliminary stage, but subsequently the alternative route was dropped due to intense lobbying. The final railway line encroached on estuaries, bays, lakes and rivers. Peasants protest that this reckless destruction of wetlands would deplete the water table and destroy the paddy fields have been ignored.

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Hastily prepared EIA plans instead of protecting the environment might damage the environment, hurt the poor and divide the society (Gadgil, 1993).

Check Your Progress - 1,2 & 3

1. What is the purpose of impact assessment?
2. Name any field in which impact assessment is done.
3. What do you mean by EMP and EIA?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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BRAOU

21.4. CASE STUDIES

21.4.1. Hussainsagar Lake

Due to the EIA/EIS studies on water pollution that were undertaken in 1991 and 1995 the environmental hazard the lake poses to the habitats around the lake have come to light. The lake which provided clean, drinking water to the city, has now turned into a cesspool of pollution by toxic pollutants. Dr. T.V.K Singh of Andhra Pradesh Agriculture University (APAU) in 1991 has reported the emission of noxious gases in the form of sulphur dioxide, hydrogen sulfide, ammonia and carbon dioxide from the surface of the lake due to decaying organisms. There are many instances of skin irritation, eyesores and allergy because of toxic emissions. In 1993, in the analysed water samples from the lake it was found that they contain oils, phenols, nitrites, phosphates and decaying organic matter. The colour of the water was black indicating that oxygen was present in the water. Flouride content was 11-20 ppm against a safe level of 1.2 ppm. A test bore well dug adjacent to the lake also contained fluorides 13-35 ppm and therefore unfit for human consumption.

If a proper EIA plan can be drawn up, a number of sewerage outlets can be diverted to primary treatment plants, then the treated water can be released for agriculture. Kolleru lake in West Godavari which is the biggest fresh water lake also presents a similar case study.

21.4.2. Kolleru Lake

In a tropical country like India, wetlands are far and few, and very beautiful. One such wetland ecosystem is Kolleru lake. Situated on the far eastern side of the state of Andhra Pradesh, in Southern India, this is the largest natural freshwater lake in India. Its expanse extends into the district of West Godavari and Krishna. It comprises parts of Eluru, Peddapadu, Denduluru, Bhimadolu, Unguturu, Nidamarru and Akiveedu mandals of West Godavari, and Kaikalur and Mandavalli mandals of Krishna district.

There are 50 island villages and 98 border villages inhabitated by a population of 2,00,147 (1981 Census), in the lake region. Fishing is the main source of occupation to the residents of 50 island villages though agriculture is also practiced on a smaller scale. However, the major occupation of people in border villages is agriculture.

The lake spread area varies with the seasonal inflows. Based on 1966 Irrigation Survey, the waterspread areas was as follows :

Contour	Area in sq.km.	Area in Hectares
+3' MSL	135.0	13,500
+5' MSL	300.4	30,040
+7' MSL	675.0	67,500
+10' MSL	901.0	90,100

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The lake receives water from 2 seasonal rivers, 15 inflowing channels and 15 inflowing drains, from a catchment area comprising of 3,405 sq.km of upland and 1,360 sq.km of delta, totaling 4,763sq.km. The total inflows into the lake are estimated to range from 65,000 cusecs to 1.1 lakh cusecs. Industries in catchment area found this the best spot to dilute their effluents. All the effluents from 10 major industries which include sugar, paper and chemical industries join the lake through the drains. The municipal effluents from Vijayawada, Eluru and Gudivada also enter into this lake. In addition, all the human waste from neighbouring villages, and island villages, find the way into the lake. Further, the agricultural run-off from the whole of 1300 sq.km of delta and 2,552 sq.km of upland catchment area enters into the lake bringing nutrients like potassium, phosphates, nitrates, pesticides and fungicides. Thus, these effluents have been continuously decreasing the quality of water.

The lake was once teeming with birds. It was reported long back about Gray pelicanries harboring more than 8,000 pelicans. Though Kolleru was declared as a protected area in 1962 and a sanctuary in 1972, Pelican disappeared since 1973. More than 185 species have been identified in 1985 which include resident and migratory birds. The migrants also include non-local migrants. The bird population is on the decline due to the destruction of habitat and the human interference.

The lake is inhabited by 43,928 fishermen, because it is an important source of natural fish wealth. In 1974, the lake produced 7,000 tons of fish and freshwater prawn. It is renowned for the air-breathing fish such as Saccobranchues Anabas (Climbing Porch), Channa (Murrels), etc. Though necessary rules for conservation of capture fishery were formulated during 1956, they were not followed. The government largely confined itself to development of aquaculture. Extensive type of pisciculture was introduced by government in 1978 by forming fishermen cooperative societies, and since then 133 fish ponds in an area of 5,000 acres in the public sector have been created in the lake while fish ponds in private sector cover an area of 20,000 acres. Many of these ponds have bunds with a height of 3' to 10' which obstruct the natural passages within the lake.

The Kolleru lake bed is being cultivated since time immemorial. From 1940s, the area under cultivation increased enormously, and the then British government granted pattas. From 1954, so far, the government initiated 93 Cooperative Farming Societies in a total extent of 21,000 acres. The lake was known for a native paddy variety, called Yerravari. This was replaced by Nalla Arlu, Toka Sannalu, and high yielding hybrid varieties like Swarna I.R. 20, etc..

Today, the lake is the focus of encroachments. Earlier, only one crop was possible, now two crops are being raised. Illegal fish and prawn ponds have mushroomed, due to their export potential. A number of government departments have been working in isolation, and at cross purposes, especially Roads & Buildings, Irrigation and Drainage, and Department of Fisheries. The Irrigation department considers the lake as land to be developed for agriculture. For this, it has increased the discharge capacity of Upputeru for drying up the lake. Upputeru is the only outlet through which lake waters flow into Bay of Bengal. The discharge from this was raised from 6,500 cusecs prior to 1980 to 14,600 cusecs during 1986. Other departments constructed roads within the lake area without taking up cross-drainage works. Thus, everywhere bunds were created. Lack of coordination and wider perspective in space and time made these activities counter productive and brought the lake towards eutrophication, making it useless for fisheries or agriculture. The reduction in the width of natural passages within the lake and increased outflows have resulted in increased annual flooding of foreshore areas during monsoon and drying up of the lake during summers.

Due to high levels of nutrients and annual drying up, the lake harbours a diversity of weeds. On the average, the biomass production per hectare varies from a minimum of 3 to 50 tons. It is rich in floating weeds like Eicchornia, Pistia, etc., submerged weeds like Valianarle, Hydrilla, Chara, etc. The dominant weeds are Eicchornia & Ipomeres which are floating and Phragmites and Typha which are emergent.

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Presently, a Kolleru Lake Development Authority exists as a watchdog organisation to check encroachments, regulate and monitor pollution, coordinate and implement the economic developmental programmes and for restoration of ecology. Several schemes and alternatives have been considered and discussed. However, the situation is continuously deteriorating with the active involvement of important political leaders of the region in the lake's decimation. It is high time that action groups step in to save this unique wetland ecology from extinction.

21.4.3. Tanneries in Tamilnadu

The main objective of the EIA is to identify and evaluate the potential impacts both beneficial and adverse. Secondly, to understand environmental implication - social, cultural & aesthetics.

Tanning industry is not new to India. From good olden days this industry flourished, and had exported finished goods to Persian Gulf. They flourished mainly on the banks of the River Cauvery and river Yamuna. At present, majorly tanneries are spread in eight states and Union territories; the total small scale industries being 45,892 out of 65,814 total industries. Forty two percent of them are in Tamilnadu - share of Andhra Pradesh is mere two percent. For tanneries, hides, and skin of cattle are the two basic raw materials required.

For small scale industry (SSI), the requirement of hides are 1,176 million square feet, skin of over 641 million square feet. But actually, processing is 712 million square feet for SSI. The value of export under different finished leather products at the end of the eighth financial year is expected to be 34,516 million rupees. This falls under the major export revenue for the country.

Livestock production in India (in million heads)

Species	1982	1990-91	1995-96	2000
1. Cattle	194.4	202.2	207.1	213.8
2. Buffalo	69.8	79.3	85.2	93.5
3. Goat	95.3	115.9	128.8	146.8
4. Sheep	48.1	51.3	53.7	56.8

Production of Finished Leather from indigenous hides and skins

Particulars	1990-91		1994-95	
	Area (million sq.ft)	No. of pieces (millions)	Area (million sq.ft)	No. of pieces (m.sq.ft.)
1. Cattle	24.19	518	25.03	536
2. Buffaloe	10.08	245	20.64	360
3. Goat	87.40	437	101.50	508
4. Sheep	34.90	175	37.76	189

BRAOU

It was found in the districts of North Arcot in Tamilnadu, due to chrome contamination of effluents and its presence in domestic water, workers were suffering from skin diseases. Chrome tanning is efficient. But ways to reduce the impact on health and ground water contamination, and various measures in processing to bring pollution down to tolerance levels are needed. In this regard, Central Leather Research Institute, Madras, is providing guidance cell on tanneries.

The impact areas of tanneries are meteorology, air quality, site of the industry in leeward site, provide preventive measures at the source, reference to ILO Standards, handling materials within tanneries, air quality assessment at distances 5-10 km radius from the site, suggestion for adoption or upgradation of existing control measures.

21.4.4. Thermal Power Project

As impact due to urbanisation and industrialisation on environment has been considerable in the past, it is now realised that development cannot be sustained unless environment is preserved. Thyagavalli and Kadikadu are two villages of Cuddalore Taluq of north-east Tamilandu. It is bounded by Bay of Bengal to east, Uppanar backwater on the west. Two thermal power stations of 660 MW capacity each were established here. The steam generators are run by coal firing. The steam generated in turn drives the turbines. The coal is imported from Indonesia, with a calorific value of 5900 kcal/kg. Sulphur and ash content of coal is 0.10 percent and 10 percent respectively. The raw water required is desalinated sea water from the coast. Per day 18.28 million liters of water is needed, out of which 6.6 mld is utilised for steam generation. A township was proposed for 800 families near the village.

The power plant is provided with auxiliary system for handling of coal, ash. The ash storage area is about 300 hectares. The gaseous emissions are SO_2 - 330 Gm/Sec (Nox some of SO_2); Suspended Particulate matter 56 gm/sec. Noise within the plant at a distance of one meter from source is less than 110 decibels, at the plant boundary it is less than 61 decibels.

The existing meteorological conditions at the site is rainfall 1253 mm; average wind speed is 12 Kmph; temperature is 20 - 30 degrees Centigrade; relative humidity 62-79 percent. Soil is mainly sandy and coastal sandy alluvium. Shallow groundwater is good, but does not meet the industrial requirement. Deep waters are saline. Surface river system flows seasonally. The backwaters of Uppanar river is very close to the project site. Mangrove plants, sea weeds and macro algal beds are absent in Uppanar region. Fisheries present are in small sizes. No forest is found within 20 km. Variety of flora and fauna exist. Land is generally used for agriculture (60 percent). Industries are fast picking up. There are 37 large and medium scale units in Cuddalore Taluq.

Impact of the plant on the environment is many fold. There was no major displacement problem. Also, to tackle the industrial pollution, a ESP is provided to remove SPM and the residual gases are vented through a tall stack of 275 metres. Incremental increase of sulphur dioxide is 28-35 g/ Nm3 and the total concentration is maintained at 39.85 g/NM3. Increase in Nox shall be 28.2 g/ NM3 and total concentration is maintained at 44.9 g/NM3.

SPM increase shall be 5 g/NM3 and the total shall be 111 g/NM3. Water spray at the cool yard will suppress dust. Retention of water at the ash pond prevents fugative dust formation. Effluent treatment plants have been constructed to suit waste characteristics. Ash will be stored in ponds with bentonite clay to prevent ground water contamination. Ash shall be utilised for manufacture of cement and other building materials.

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21.4.5. Natural Resource Accounting of Mamandoor Village

Mamandoor is a forest village, located in the midway of Kodur-Renigunta of Sri Venkateshwara National Park. Towards the east, is bounded by Karkambadi reserved forest. It is therefore imminent that the people of this village live on forests. For about nine hundred inhabitants consisting of tribes, Yanadis, other communities include Muthrasis, Muslims and Balijas.

To record the use of non-marketed forest produce, which could enable to know the sustenance of the people on forest, a study was conducted in July 1996, by V.R. Sowmitri et al.

The following table gives the end result and assessment :

Table 21.1. Consumption of Non-Marketed Forest Produce by a single Family

Use	Quantity	Estimated Value per annum	Estimated value after one time
1. Shelter	-	-	Rs.8,87,750.00
2. Food	80,700	Rs. 3,99,900.00	-
3. Fuelwood	1,46,730	Rs. 2,20,095.00	-
4. Fodder	20,48,380	Rs.15,20,882.00	-
5. Medicinal Plants	12,48,900	Rs. 5,70,905.00	-
		Rs.27,11,782.00	Rs.8,87,950.00

The above table reveals that around Rs.36 lakh worth of forest protduce is consumed at domestic level.

If these communities were to be rehabilitated, it should amount to a sum four time to this total, in terms of relocation of shelter, land for tilling, subsidies etc.. Not only this, the social cost and opportunity cost by the agricultural villagers if accounted would give a un-sustainable amount. But, if these communities continue to be inside the forest, their collection do not destroy the green cover, they need not uproot the trees, they are quite aware that forest is their life. Hence, options like Joint Forest Management, alternate fuel resources could help them to live a sustained life then by rehabilitation.

21.4.6. Impact of Human Activities in Giri Catchment Area

The main occupation in the Giri catchment area in the state of Himachal Pradesh is agriculture. More than 90 percent of the work force was employed in it either as cultivators or labourers. On the whole, they could work for 211 days in a year. The rest of the year they were unemployed. Since only 26 percent of the land was under cultivation, employment in agriculture was also in the form of disguised unemployment. A higher yield could possibly be achieved by employing less people and using more scientific methods.

It was found that the cultivators felt satisfied with the level of production they get. On its own this seems to be a good attitude as it will not cause further exploitation of the land resources. But there was a paradox. If this level of subsistence cultivation was followed, firstly, they were not able to generate additional income for their other necessities and, secondly, the total economy suffers. The low income was consequently responsible for environmental deterioration in various ways. It was concluded that the cultivators either lacked the knowledge or the motivation to get higher yield.

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The low level of income could be the cause of many environmental deteriorating activities like felling of trees for fuel wood or overgrazing of pastures etc.. If they had higher income and considering the finding that most of them are aware of the benefits of forests it might be safely assumed that they would have acquired alternative, more expensive fuel material. Similarly, more income would help the people afford to buy fodder and help to prevent overgrazing and subsequent soil erosion.

However, at the same time the low income was a result of the inability to tap natural resources properly as was shown by the use of primitive cultivation practices. To increase income would mean exploitation of natural resources to some extent.

The livestock population in the area was quite high (7.37 per respondent). Grazing in state forest was allowed only to right-holders under the terms of settlement, and limited area was available for grazing to most of the livestock. This will naturally lead to overgrazing of the limited available pasture. There can be two possible remedies, decrease the number of livestock, or increase the area of land under pasture and income of the livestock owners so that they could afford to buy fodder from market. Improved breeds could be a solution to the problem and income. From the analysis of the material used for fuel, it is found the wood was commonly used. to decrease the practice of cutting trees for fuel wood, alternatives have to be made available and simultaneously their capacity to buy the fuel will be enhanced. Making available fuel efficient chulhas and more biogas plants is necessary.

21.5. DAMODAR RIVER SYSTEM

Damodar river originates in the Chhota Nagpur plateau in Bihar. It flows along a course of 500 Kms through Bihar and West Bengal before joining the Hooghly river. It's tributaries are Barakar, Jamuria, Konar and Bokaro. This river receives very high concentration of sediment and debris from the adjoining mines causing problems of siltation and thus a rise in the river bed level causing floods.

21.5.1. EIS/EIA of Damodar River

Under the Ganga Action Plan (GAP, 1981-1984), EIA studies were undertaken jointly by the Damodar Valley Corporation (DVC) and the Government of West Bengal during 1984-1989. The main pollutants in the river were cyanides, hydrocarbons, phenols, tannins, lignins, insoluble fats and miscellaneous pollutants. Arsenic, mercury, lead and chromium from leather and dye industries are also discharged into the river. For the 160,000 cubic meters of effluents being discharged into the river daily, there is requirement 24,000 kgs of oxygen demand (OD). This is the amount of untreated sewage produced by a city of 100,000 people daily. The cost estimates are that Rs.2.5 crores will be required to treat the water to a acceptable standard. This is a very small percentage of the total operating costs of the industries located on the Damodar river.

The toxic loading at Burnpur about 200 Km from Calcutta is as follows :

Ammonia 47-60 ppm

Cyanide 0.08-0.1 ppm

nitrate & nitrites 15-35 ppm

total dissolved solids 200 ppm

chemical oxygen demand (COD) 30-46 mg/lt

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The sediments at the down stream of Durgapur barrage act as a store house of all the pollutants and slowly leach back to the waters, thereby increasing the pollution concentration in the river. Water contamination will continue long after the source of pollution of is removed. Presently, drinking water treatment plants are applying conventional methods such as sedimentation, chlorination, flocculation and sand filtration. These methods cannot remove organic pollutants and toxic metals. Consumption of water laden with toxic compounds is the cause of many illness such as liver disorders, blood poisoning, hepatitis, jaundice, dysentery, etc., while the foul smell emanating from the river causes asthma and other respiratory disorders. The Minamata Tragedy in Japan in 1953 due to mercury poisoning by the Sumitomo Chemical Industries where many lives were lost could also occur in India.

21.5.2. Environmental Management Plan (EMP) for Damodar River

Based on the EIA findings of the pollution levels and their causes a long term EMP has to be drawn up. The plan should consist of the following components :

a) Surface water quality monitoring stations. These stations monitor the river quality on a daily basis in accordance with the Water Pollution Act, 1974. A large number of such stations make a network to monitor the Damodar river, it's tributaries and the Hooghly river.

b) Coastal water quality monitoring stations. Since the Damodar river empties all it's effluents into the Hooghly estuary a coastal water quality monitoring network is essential. The Department of Ocean Development and the Calcutta Port Trust have initiated steps to establish this network in 1990. Data pertaining to 25 parameters is being processed. Sanction has been obtained for 173 sites where the stations will be located along the Sunderbans and Orissa coast till Chilka lake; a distance of 500km.

Other major works that should be undertaken under EMP :

1) Renovation of existing trunk sewers in order to prevent the outflow of sewage and other liquid wastes from the river.

2) Renovation of sewage treatment with emphasis of recovery of heavy metals and methane. This will make the water safe enough for agriculture.

3) Low cost sanitation schemes are absolutely essential.

4) Cooperation of industries, mining and thermal power plants is essential so that the effluents released from each of them can be treated at a central location before being released into the river.

5) Treatment of river water before being distributed as potable water in accordance with the national standards.

Adjacent to the Damodar river, many research establishments and universities exist which can take up research projects pertaining to all aspects of EMP.

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21.6. CONCLUSION

EIS/EIA are necessary to gain an overall picture of the project from inception, construction, operation and final shutdown phase. Based on EIA/EIS studies, an Environmental Management Plan (EMP) can be drawn covering a period of more than ten years.

Check Your Progress - 4,5,6,7 & 8

4. What is the fluoride content of Hussainsagar lake?

5. Where is Kolleru lake situated?

6. What percentage of Indian tanneries are located in Tamilnadu?

7. What is ESP and SPM?

8. Where does Damodar river originate?

Note : (a) Write the answers in the space provided below.

(b) Compare your answers with those given at the end of this unit.

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21.7. SUMMARY

In this unit we have seen the importance of the impact assessment for various projects. Assessment is essential for not only major projects but also medium and minor projects. Any impact assessment should involve the local people and all the information about the proposed project should be made available to these people so as to elicit their opinion and consent for the project. But it has been the practice of the government and the industries to withhold all information and maintain high levels of secrecy. It should also be noted that impact assessment should not only include the impact on the ecology but also on the socio-economic and cultural lifestyles of the local people.

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21.8. CHECK YOUR PROGRESS : MODEL ANSWERS

1. The purpose of impact assessment is to comprehensively bring out the true picture of the environment, and human beings interaction with nature on a day to day basis.

2. In day to day pollution control monitoring the impact assessment is done.

3. Environmental Management Plan (EMP) and Environment Impact Assessment (EIA).

4. As against safe levels of 1.2ppm the fluoride content of Hussainsagar lake is 11-20ppm.

5. It is located on the far eastern side of India, i.e, in West Godavari district of Andhra Pradesh.

6. 42% of the Indian tanneries are located in the state of Tamil nadu.

7. Electro Static Precipitator (ESP) and Suspended Particulate Matter (SPM).

8. River Damodar originates in the Chota Nagpur plateau in Bihar.

21.9. MODEL EXAMINATION QUESTIONS

I. Answer the following questions in about 30 lines each.

1. Discuss the importance of impact assessment?
2. Elaborate on the impact assessment of Kolleru Lake?
3. What factors should be looked into while assessing a river valley project Enumerate with example?
4. How do you go about Resource Accounting for villages?

II. Answer the following questions in about 10 lines each.

1. What is the role of decision making in impact assessment?
2. Write a note on impact assessment of tanneries?
3. Describe Thermal power plants impact on environment.
4. What are the fields in which impact assessment is done?

BRAOU

D. Narasimha Reddy

BRAOU

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Course - IV : Environment : A Social Science Perspective

MODEL EXAMINATION PAPER

Time : 3 Hours | Max. Marks : 100

SECTION - A

4 x 15 = 60

Answer any **Four** of the following questions.
Each question carries 15 marks.
Answer in about 30 lines each.

1. Write briefly about major global concerns.
2. Briefly write about the concept of sustainable development
3. What are the differences in the quality of lifestyles in the developing and developed world.
4. Write briefly about major and minor dams.
5. What is green revolution? Write briefly about it.
6. Write briefly about various industries in Patancheru and its surroundings and explain the pollution caused due to them.
7. Write briefly about environmental health hazards.
8. Briefly enumarate the main features of Stockholm conference. How successful was it in promoting International concern for the environment.

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SECTION - B

5 x 8 = 40

Answer any **Five** of the following questions.
Each question carries 8 marks.
Answer in about 10 lines each.

9. Briefly write about industrial technology.
10. Write briefly about the types of renewable resources.
11. Briefly write about hydrocarbons.
12. What are mangroves? Write briefly about them.
13. What are the reasons for the migration of people into cities.
14. Write about radioactive waste disposal.
15. What was the compensation given due to Nizam Sagar Project?
16. How are the national policies on the environment affected by International environment agreements?
17. Write briefly about Public Liability Insurance Act, 1991.
18. What are the fields in which impact assessment is done?

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ASSIGNMENT - 1

Time : 2 Hours

Note :

1. *Do not copy the answers from any of the books.*
2. *As far as possible, try to answer the questions independently in your own words.*
3. *If it is necessary to your quote from any source, give the correct reference.*
4. *Use your own foolscap pages for writing the assignment.*
5. *Leave sufficient margin for the comments of the evaluator.*
6. *Completion of this assignment should not take more than two hours time.*

BRAOU

I. Answer the following questions in about 30 lines each.

1. Write briefly about major global concerns.
2. Briefly write about the concept of sustainable development.
3. What are the differences in the quality of lifestyles in the developing and developed world.

II. Answer the following questions in about 10 lines each.

1. Briefly write about industrial technology.
2. Write briefly about the types of renewable resources.
3. Briefly write about hydrocarbons.

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ASSIGNMENT - 2

Time : 2 Hours

Note :

1. *Do not copy the answers from any of the books.*
2. *As far as possible, try to answer the questions independently in your own words.*
3. *If it is necessary to your quote from any source, give the correct reference.*
4. *Use your own foolscap pages for writing the assignment.*
5. *Leave sufficient margin for the comments of the evaluator.*
6. *Completion of this assignment should not take more than two hours time.*

BRAOU

I. Answer the following questions in about 30 lines each.

1. Write briefly about major and minor dams.
2. What is green revolution? Write briefly about it.
3. Write briefly about various industries in patancheru and its surroundings and explain the pollution caused due to them.

II. Answer the following questions in about 10 lines each.

1. Briefly write about mangrove Vegetation.
2. What are the reasons for the migration of people into cities?
3. Write about radio active waste disposal.

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ASSIGNMENT - 3

Time : 2 Hours

Note :

1. *Do not copy the answers from any of the books.*
2. *As far as possible, try to answer the questions independently in your own words.*
3. *If it is necessary to your quote from any source, give the correct reference.*
4. *Use your own foolscap pages for writing the assignment.*
5. *Leave sufficient margin for the comments of the evaluator.*
6. *Completion of this assignment should not take more than two hours time.*

BRAOU

I. Answer the following questions in about 30 lines each.

1. Write briefly about environmental health hazards.
2. Briefly enumarate the main features of Stockolm conference. How successful was it in promoting international concern for the environment?
3. Write an account on silent vally movement.

II. Answer the following questions in about 10 lines each.

1. What was the compensation given due to Nizam Sagar Project?
2. How are the national policies on the environment affected by International environmental agreements.
3. Write briefly about Public Liability Insurance Act, 1991.

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